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1989 Simulation of the ProposedEnd-Result Specification for Acceptance Based on Aggregate Gradation and Asphalt Cement Content

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

1989 Simulation of the Proposed End-Result Specification for Acceptance Based on Aggregate Gradation and Asphalt Cement Content

by

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ABSTRACT

A special provision for the acceptance and price adjustment of hot mix based on aggregate gradation and asphalt cement content has been drafted. The proposed system considers lots of hot mix of approximately 2,000 t from which 4 samples are taken and tested for AC content and aggregate gradation. Limits are set for the permissible deviation of the average of the 4 results from the job mix formula. Permissible ranges of the 4 results are also set. If the average results obtained lie within the permissible limits, the material is paid for at the full contract price. If the results lie outside the permissible limits, a system of payment reductions is applied, up to a specified amount. Beyond this limit, the material is rejectable and may not be accepted into the work. Remedial actions may be required.

Following a limited simulation, carried out in 1988, of the impact of introducing this scheme on Ministry contracts, a much larger simulation was carried out based on test data from Ministry contracts during 1989. The services of two consultants specializing in this area of work were retained by the Ministry to comment on the proposed scheme. Some of the recommendations made by these consultants were studied in detail as part of the 1989 simulation exercise. The 1989 simulation sought to determine the financial implications of introducing the scheme, and of adopting some of the recommendations presented by the Ministry's consultants.

As a result of these studies, recommendations for the introduction of the scheme are presented. This report recommends that the acceptance procedure presented in the draft special provision will form the basis of the final scheme. Adjustment points will be determined for the Mean and Range requirements based on the tolerances developed by the Ministry. Payment reduction factors will be determined from the accumulated adjustment points for each designated sieve and the asphalt cement content. Formulae have been developed to perform this calculation.

It is recommended that the procedure be phased in over a period of two years. In the first year 10% of the final payment reduction will be applied. In the second year this will increase to 50% of the final payment reduction with full implementation occurring in 1993.

1 INTRODUCTION

The Ministry intends to introduce a Price Adjustment Acceptance Procedure based on aggregate gradation and asphalt cement content as part of the End-Result Specification for bituminous materials. It is proposed to implement the scheme in late 1990 but before including the new procedure into Ministry contracts it is important to ensure that it is equitable to both the contractors and the Ministry. One means of achieving this is to simulate the effect of implementing the proposed scheme using real test data obtained from Ministry contracts.

2 CURRENT ACCEPTANCE PROCEDURE

Under the current acceptance procedure, governed by Ministry Directive B-138, material is assessed on the basis of a single test determination for three attributes - the asphalt cement content and the aggregate proportions on the 4.75 mm and 75 µm sieves. No acceptance criteria are currently in place for the Range or Standard Deviation of a series of test results.

Acceptable, Borderline and Rejectable limits have been set for the three criteria although no action is taken if the material is determined to lie in the Borderline zone other than to inform the contractor that a problem exists. A coring program is initiated if material is identified as Rejectable in order to identify the limits of the rejectable material. Test results on the recovered cores are then used to determine what action is to be taken. If the core results do not support the original determination, the material is deemed to be acceptable - no action is taken and payment is made at the full tender price. If the core results support the original determination a decision is made as to whether a price adjustment is to be applied or removal of the defective area is required. Price adjustments are based on anticipated loss of life due to low asphalt cement content plus a 1% penalty for each 1% deviation in coarse aggregate content on the 4.75 mm sieve.

In 1988 the Ministry introduced tolerances on the full aggregate gradation. Any results outside the Acceptable range were identified and brought to the contractor's attention. No further action was taken on such non-acceptable results (other than the 4.75 mm and 75 µm sieves) but the procedure did serve to provide the contractor the opportunity to prepare for future requirements.

3 SUMMARY OF THE PROPOSED ACCEPTANCE PROCEDURE - FEBRUARY 1989

A copy of the Tables, from the draft special provision "Acceptance and Price Adjustment Based on Asphalt Cement Content and Aggregate Gradation" dated February 1989, are attached as Appendix A. These Tables give the maximum permissible tolerances from the job mix formula and provide the means for determining adjustment points and pay factors. The proposed acceptance procedure can be summarized as follows:

1. The hot-mix produced is divided into lots of approximately 2000 t and generally consists of 4 equal sub-lots. A random sample is taken from each sub-lot for testing to determine the AC content and aggregate gradation.

2. The results of the 4 tests for the lot are evaluated to determine means and ranges for each sieve size and the asphalt cement content. These results are compared to the job mix formula.

3. Limits for the permissible deviation of the means from the job mix formula are set in the special provision, as are permissible ranges of the 4 individual results. If the results obtained lie within the permissible limits, the material represented by the lot is accepted and paid for at the full contract price.

4. If the results obtained by the testing lie outside the permissible limits, pay factors are calculated in accordance with the draft special provision. The magnitude of the price penalty is exponential, being small for a slight deviation from the permissible limits but severe for gross deviations.

5. When the deviations become very severe the material is rejectable and may not be accepted by the Ministry into the work. Remedial actions may be required.

Example calculation sheets are shown as Tables 1, 2 and 3. Table 1 illustrates acceptable material paid at the contract price. Table 2 illustrates a lot where a price reduction is identified, while Table 3 illustrates a rejectable lot.

4 1988 SIMULATION

A limited simulation was carried out based on a small sample of test data obtained from actual projects constructed in 1988. The 1988 simulation analysed the data from 286,500 tonnes representing 14.3% of the total tonnage of 2,002,147 tonnes placed across the Province on Ministry contracts that year. The simulation was carried out on a wide number of mix types produced in both drum and batch plants with aggregates derived from both commercial and wayside operations. A summary of the findings of the 1988 simulation is given in the following table.

1988 Simulation - Acceptance Summary

Mix Type	Tonnage Assessed	Tonnage Price Adjusted	Per Cent Price Adjusted	Tonnage Rejected	Per cent Rejected
Surface Course	144,000	39,500	27	3,500	2.4
Binder Course	140,000	46,500	33	5,000	3.6
All Mixes	284,000	86,000	30	8,500	3.0

The cost implications of introducing the scheme would have been as follows:

1. 3.0% (or 60,064 t) of all material placed in 1988 would have been rejectable. At $40 per tonne this represents $2,402,560.

2. 30% (or 600,644 t) of all material placed would have had an average price reduction of 8% off the tender price. At $40 per tonne this represents $1,922,061.

3. The total price penalty would therefore have been $4,324,621.

4. The total value of hot mix placed on Ministry contracts in 1988, including the cost of the AC, was approximately $80,080,000

5. The actual price penalties imposed which resulted from non-compliance with the job-mix formula as determined in accordance with Directive B-138 was $157,668.

5 CONSULTANT'S RECOMMENDATIONS

A second simulation was planned for 1989. However, before the simulation was carried out, the services of two consultants specializing in this field of work were retained by the Ministry. One consultant, James A. Scherocman from Cincinnati, Ohio, has considerable experience in the hot mix construction field while James L. Burati from Clemson, South Carolina specializes in statistical specifications. Both consultants made a number of recommendations to modify the acceptance procedure. Some of these recommendations were investigated in detail in the second simulation as follows:

5.1 It was suggested that the tolerances proposed were too relaxed compared with the tolerances generally recognized as typical for North America and published by ASTM. The 1989 simulation was therefore run a second time using the tolerances given in ASTM D3515. In addition, it was questioned why different tolerances were permitted for HL-8 mixes, which have a maximum aggregate size of 26.5 mm, when the same process is used for their production as for all other mix types. When reassessing the data using ASTM criteria the HL-8 mixes were assessed using the same tolerances as other mixes.

5.2 It was recommended that the inclusion of "....adjustment points on all sieves required in the gradation of the mix being produced is unusually harsh. It is thus suggested that the number of sieves subject to the assessment of adjustment points be reduced." In view of this recommendation, both simulations (i.e. using both Ministry and ASTM tolerances) were repeated but with a number of sieves omitted.

5.3 It was suggested that the stepped table for the determination of the pay factor was inequitable and could be contentious. The February 1989 version of the acceptance scheme determines the pay factor (the value by which the tender price is multiplied to get the payment price) from Table 5 of the acceptance procedure. This leads to large changes in the pay factor for relatively small changes in the total adjustment points, particularly when the accrued adjustment points value is large. For example; if 26

adjustment points are accrued the pay factor is 0.50 but if the adjustment points increase to 27 points the pay factor is only 0.44. This stepped Table was suggested as being inequitable and could lead to protracted arguments over fractions of adjustment points. Therefore, a formula for the calculation of the pay factor was derived. This formula provides a smooth relationship between adjustment points and pay factors. It was important that the formula not only generated the same pay factors as the tabular values but also it had to be easy to use in day-to-day operations in the field.

Later it was reasoned that, when this new formula was applied to high values of adjustment points, the graph of adjustment points v. pay factors was still too steep. This could again lead to protracted arguments over test results because of the large financial implications of small changes in the test data. Another relationship was therefore established based on two straight lines of different gradient. This change was also evaluated.

5.4 It was recommended that the range of permitted pay factors is too large. The scale of pay factors in Table 5 cuts off at a pay factor of 0.26 corresponding to 29 adjustment points. Below a pay factor of 0.26 the material is determined as being rejectable and remedial action may be required. It was suggested that a pay factor of 0.26 was too low and that the table should be terminated at a pay factor of between 0.50 and 0.70. The effect of this readjustment of the relationship between total adjustment points and pay factors was investigated.

5.5 It was suggested that the manner in which the proposed acceptance scheme determines the acceptability of small quantities of mix, sufficient for only 1, 2 or 3 sub-lots, although not incorrect, was unusual. One recommendation that was made was to consider three sub-lots as a separate lot. Acceptance criteria would have to be developed for these smaller lots. One or two sub-lots would be added to previous lots making larger lots consisting of five or six sub-lots. Because of this change to the existing acceptance scheme, it was decided not to include any lots consisting of 1, 2 or 3 sub-lots in the simulation - only full lots representing about 2,000 tonnes each were considered.

6 1989 SIMULATION

It was considered necessary to carry out a second simulation in 1989 because of the very limited size of the 1988 exercise. In addition, many contractors had been introduced to Process Control requirements on a large number of contracts during the 1989 construction season. Process Control requires the contractor to carry out testing of materials, both on the aggregates and the hot mix produced. With this knowledge of the available materials it was reasoned that the contractor would now be in a better position to control the quality of material output from the plant.

Based on the recommendations previously discussed, the following simulations were carried out:

1. MTO Criteria incorporating the full aggregate gradation
2. MTO Criteria using a reduced number of sieves
3. ASTM Criteria incorporating the full aggregate gradation.
4. ASTM Criteria using a reduced number of sieves

These assessments were then used to make further analyses of the data:

Determine the effects of smoothing the adjustment point vs. pay factor Table
Determine the effects of increasing the pay factor cut-off point
Determine the influence of mix type on the computed pay factors

The total quantity of material included in the 1989 simulation was 780,000 tonnes. This represents 51.6% of the 1,510,000 tonnes (approximately) of hot mix placed on Ministry contracts in 1989. The tolerances and adjustment tables adopted were the same ones used for the 1988 simulation detailed in the draft special provision "Acceptance and Price Adjustment Based on Asphalt Cement Content and Aggregate Gradation" dated February 1989.

In identifying the cost implications of introducing the scheme based on test data from both the 1988 and the 1989 construction sites it has been assumed that, once a lot has been determined as rejectable, all material within that lot will have to be removed or overlaid at no cost to the Ministry. This will not in fact occur. It is not in the interest of either the contractors or the Ministry to reject material when it is not necessary to do so. Under the proposed scheme the contractor will be given the opportunity to

repair the rejectable lot. After repairs, the lot will be re-decisioned and thus the cost implications of the scheme will be reduced significantly from the simulated cost.

A summary of the simulation results is given in Table 4.

7 ANALYSIS BY MTO CRITERIA - ALL SIEVES

The MTO criteria are detailed in the draft special provision Acceptance and Price Adjustment Based on Asphalt Cement Content and Aggregate Gradation dated February 1989 and this simulation included the assessment of price adjustments on all sieves. A detailed assessment of this simulation is given in Appendix B and a summary of the results is given below:

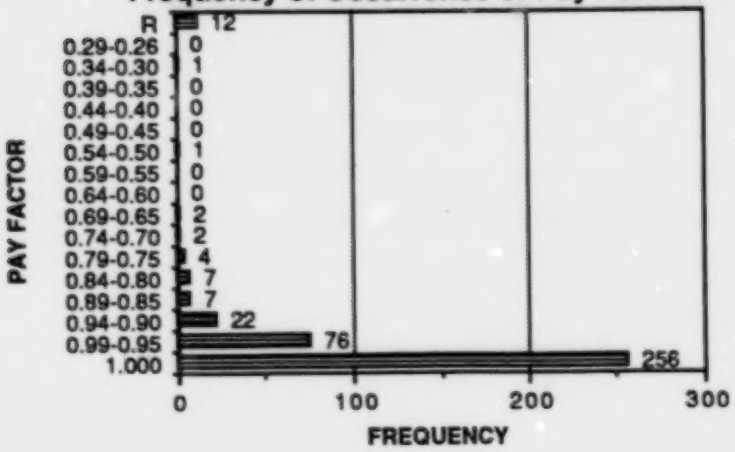
1. 12 lots representing 3.07% of the total were determined as being rejectable. Of these, 6 lots were from the same contract.

2. The average pay factor for the non-rejectable lots was 0.977.

3. 52% of the adjustment points were accrued by deviation from the Mean, while 48% were accrued due to Range deviations.

4. Fig. 1 indicates the frequency of occurrence of the various ranges of pay factors in increments of 0.05. 256 lots representing 65.6% of the total would have received full payment while 354 lots representing 90.8% of the total would have incurred pay factors equal to or greater than 0.90.

FIG. 1 MTO FULL CRITERIA
Frequency of Occurrence of Pay Factors



8 ANALYSIS BY MTO CRITERIA - REDUCED NUMBER OF SIEVES

The suggestion was made that "....the gradation of the aggregate on one sieve usually is dependent, in part, on the gradation of the aggregate on the next largest sieve. Thus, if the gradation is off on one particular sieve, it is likely also to be off on several adjacent sieves. .....It is thus suggested that the number of sieves subject to the assessment points be reduced." It was recommended that only two coarse aggregate sieves be included plus the 4.75 mm. For the fine aggregate fraction, it was recommended that the 1.18 mm and the 150 µm be omitted and consideration be given to omitting the 2.36 mm sieve as well. However, this sieve was retained for the purposes of this simulation. A detailed assessment of this simulation is given in Appendix B and a summary of the results is given below:

1. 9 lots representing 2.31% of the total were determined as being rejectable. Of these, 3 lots were from the same contract.

2. 262 lots representing 67.2% of the total would have been paid at the full contract price.

3. The average pay factor for all the non-rejectable lots was 0.980.

The projected cost implications of applying the proposed schemes to the total quantity of hot mix placed on Ministry contracts in 1989 were investigated. Based on an average price of hot mix of $40 per tonne, the costs were calculated as follows:

Acceptance Procedure	Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
MTO Tolerances - all sieves	$1,854,280	$1,346,551	$3,200,831	$2.12
MTO Tolerances - reduced sieves	$1,395,240	$1,180,095	$2,575,335	$1.70

9 EFFECT OF SMOOTHING THE PAY FACTOR DETERMINATION

A formula for the determination of the pay factors from the total adjustment points was derived to replace Table 5 of the Acceptance procedure. The discrete nature of the adjustment points in Table 5 could potentially lead to inequitable payments. The formula had to produce values of pay factors as close as possible to those given in Table 5 but at the same time be simple to use in day-to-day field operations. It was therefore restricted to second order calculations only. The formula used for the determination of the pay factor for bridge deck waterproofing formed the basis of the calculation.

The derived formula for pay factors in the range 1.00 to 0.26 is as follows:

$$\text{Pay Factor} = \frac{\sqrt{\left(1 - \frac{P^2}{900}\right) 5476} + 26}{100}$$

where P = Total Adjustment Points

The effect of replacing Table 5 with the derived formula is to change the mean pay factor for the non-rejectable material from 0.977 to 0.983 when all sieves are included in the acceptance procedure. Thus the total price penalty, if the scheme had been applied to all hot mix placed on Ministry contracts in 1989, would have reduced from $1,346,551 to $995,277.

Applying the formula to the data derived using the MTO criteria but with a reduced number of sieves increases the mean pay factor for the non-rejectable material from 0.980 to 0.986. Thus the total price penalty, if the scheme had been applied to all hot mix placed on Ministry contracts in 1989, would have reduced from $1,180,095 to $826,067.

10 EFFECT OF CHANGING PAY FACTOR CUT-OFF

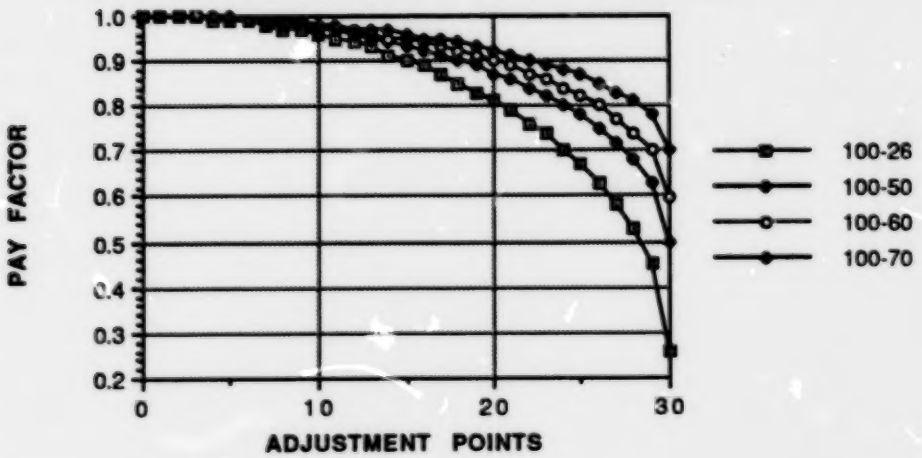
The simulated acceptance scheme allowed the pay factor to drop to 0.26 (i.e. the contractor would receive payment of only 0.26 x tender price for the lot being decisioned). One consultant recommended that consideration be given to increasing the pay factor below which material will be treated as rejectable and remedial action will be required. A pay factor cut-off in the range 0.50 - 0.70 was suggested.

An assessment was therefore made of the effect of increasing the pay factor cut-off to 0.50, 0.60 and 0.70. A cut-off of 0.26 is included for comparison. Formulae, similar to that derived for a pay factor cut-off of 0.26 and shown in Section 9 (above), were derived for the three suggested cut-off values and these formulae were used in the analysis. The findings can be summarized as follows:

Analysis	Pay Factor Cut-Off	Mean Pay Factor	Total Simulated Price Penalty
MTO Tolerances - All Sieves	0.26	0.983	$995,277
	0.50	0.989	$644,003
	0.60	0.991	$526,911
	0.70	0.993	$409,820
MTO Tolerances - Reduced Sieves	0.26	0.986	$826,067
	0.50	0.990	$590,048
	0.60	0.992	$472,038
	0.70	0.994	$354,029

The relationship between the four pay factor cut-off points is best illustrated graphically. Fig. 2 plots the payment adjustment points versus the pay factor for the various cut-off values.

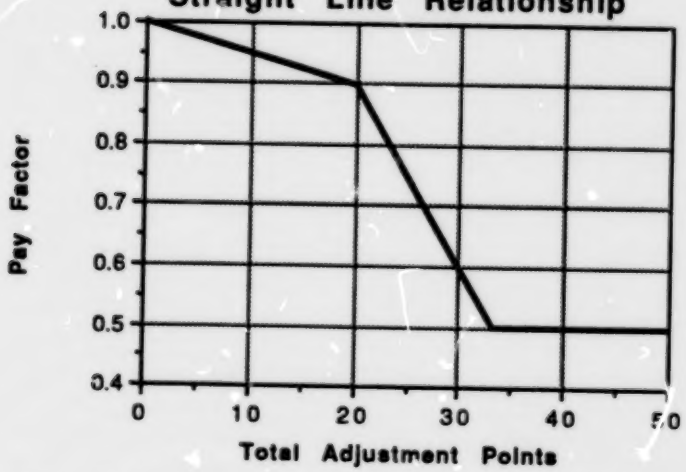
FIG. 2 PAYMENT ADJUSTMENT CURVES



11 EFFECT OF USING STRAIGHT LINE PAY FACTOR DETERMINATION

The formula developed for the determination of the pay factor from the total adjustment points removed the stepped Table from the acceptance scheme. However, it was seen that, when the total adjustment points value is high, the pay factor varies significantly with only a small change in the adjustment points. It was reasoned that this could lead to arguments over the test results. An alternative relationship was therefore developed, based on 2 straight lines, which would not create this potential conflict situation and this is illustrated graphically in Fig. 3.

Fig. 3 Payment Adjustment Straight Line Relationship



The cost implications of determining the pay factors using this straight line relationship for all lots included in the simulation are presented in Table 5. The adjustment points for this cost analysis were determined using the MTO criteria with all sieves included. The average adjustment points for the 390 lots analysed was 5.17 and the average pay factor for the non-rejectable lots was 0.983. The costs can be summarized as follows:

Scheme Summary	Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
MTO Tolerances - all sieves				
Feb. 1989 Procedure	$1,854,280	$1,346551	$3,200,831	$2.12
Straight Line Relationship	$1,854,280	$995,277	$2,849,557	$1.89

12 SUMMARY OF COST IMPLICATIONS

The cost implications of the various schemes, based on an average price of hot mix of $40 per tonne applied to the total quantity of material placed on Ministry contracts in 1989, can be summarized as follows:

Scheme Summary		** Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
MTO Tolerances - all sieves					
Feb. 1989 Procedure		$1,854,280	$1,346,551	$3,200,831	$2.12
Calculated Pay Factor with Cut-Off of:	0.26	$1,854,280	$995,277	$2,849,557	$1.89
	0.50	$1,854,280	$644,003	$2,498,283	$1.65
	0.60	$1,854,280	$526,911	$2,381,191	$1.58
	0.70	$1,854,280	$409,820	$2,264,100	$1.50
Straight Line Relationship		$1,854,280	$995,277	$2,849,557	$1.89

Scheme Summary		** Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
MTO Tolerances - reduced sieves*					
Feb. 1989 Procedure		$1,395,240	$1,180,095	$2,575,335	$1.70
Calculated Pay Factor with Cut-Off of:	0.26	$1,395,240	$826,067	$2,221,307	$1.47
	0.50	$1,395,240	$590,048	$1,985,288	$1.31
	0.60	$1,395,240	$472,038	$1,867,278	$1.24
	0.70	$1,395,240	$354,029	$1,749,269	$1.16

Notes:

* No change was made to the adjustment points when the number of sieves was reduced.

** The Cost of Rejectable Mix is not affected by changing the method of calculating the Cost of the Borderline Mix.

13 INFLUENCE OF MIX TYPE

It is possible, because the hot mix aggregates are produced in a variety of ways and from a variety of sources, that the proposed acceptance procedure might be considered severe for certain mixes and lenient for other mixes. In order to check this, data from each mix type was assessed separately and the mean values for the total adjustment points and the pay factors computed. This process was repeated for the case where the number of sieves was reduced. The findings are as follows:

13.1 Full gradation

Mix Type	Mean Total Adjustment Points	Mean Pay Factor	No. of Lots
HL-3	1.451	0.994	22
HL-4	6.364	0.971	124
HL-8	13.913	0.965	42
DFC	3.278	0.984	23
OFC	5.289	0.984	14
RHM	2.996	0.981	165
		TOTAL	390

13.2 Reduced gradation

Mix Type	Mean Total Adjustment Points	Mean Pay Factor	No. of Lots
HL-3	1.287	0.995	22
HL-4	5.236	0.980	124
HL-8	9.401	0.938	42
DFC	2.743	0.990	23
OFC	2.910	0.988	14
RHM	2.524	0.987	165
		TOTAL	390

The Mean Total Adjustment Points include data from all lots. The Mean Pay Factors given do not include any lots which were identified as rejectable but do include those lots which would have been paid at the full contract price. It will be noticed that, for some mixes, the mean pay factor has dropped when changing from acceptance based on the full gradation to the reduced gradation. This is due to the shift of some lots previously identified as rejectable into the price adjustment category, but with a small pay factor.

The mean total adjustment points for the HL-8 mixes include the data from Contract 88-67 (see Appendix B for details of this contract) which has increased the mean value significantly. The mean pay factor for these HL-8 mixes, which does not include data from the rejectable lots, is more in line with the means for the other mixes. The means for the recycled mixes (RHM) are similar to the means from the other mix types.

14 EFFECT OF CHANGING HL-8 TOLERANCES

Under the simulated acceptance scheme the HL-8 mixes were assessed using a different set of tolerance limits from those used for all the other mixes. This was done because it was thought that, due to the larger aggregate size in the HL-8 mix, a wider variation in test results could be expected. One of the consultants, however, recommended "....the same tolerance values should be applied to all asphalt concrete mixtures." The consultant reasoned that "....the tolerance limits used for all asphalt concrete mixtures should be identical if the performance and durability of the mix under traffic is expected to be the same." The effect of changing the tolerance limits for the HL-8 mixes was investigated and the results are summarized in Table 6. The results indicate the following:

1. The number of rejectable lots increases from 7 to 11 using the standard tolerance limits.

2. The average Total Adjustment Points for the 42 lots of HL-8 included in the simulation increases from 13.91 to 26.57.

3. The average pay factor for the non-rejectable lots reduces from 0.965 to 0.896.

15 ANALYSIS BY ASTM CRITERIA - ALL SIEVES

The ASTM criteria are detailed in specification D3515 "Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures". The tolerances for 4 sub-lots are summarized (with MTO criteria for comparison) as follows:

PARAMETERS	ONTARIO SPECIFICATION	ASTM D3515 SPECIFICATION
19.0 mm	±5.0	±4.0
16.0 mm	±5.0	±4.0
13.2 mm	±5.0	±4.0
9.5 mm	±5.0	±3.5
4.75 mm	±5.0	±3.5
2.36 mm	±4.5	±3.0
1.18 mm	±4.0	±3.0
600 µm	±3.5	±2.5
300 µm	±3.0	±2.5
150 µm	±2.5	±2.0
75 µm	±2.0	±1.5
Asphalt Cement	±0.3	±0.25

As can be seen, the MTO criteria are more lenient than the ASTM requirements, thus it was expected that the price adjustments would be higher when the ASTM criteria were applied and that the number of rejectable lots would be increased.

A detailed assessment of this simulation is given in Appendix C and a summary of the results is given below:

1. 44 lots (versus 12 lots for the MTO tolerances) representing 11.28% of the total were determined as being rejectable.

2. 134 lots (versus 256 lots for the MTO criteria) representing 34.4% of the total would have been paid at the full contract price.

3. The average pay factor for the non-rejectable lots was 0.930.

16 ANALYSIS BY ASTM CRITERIA - REDUCED NUMBER OF SIEVES

The simulation was run for a final time using the same ASTM criteria but with a reduced number of sieves used to assess the adjustment points. The same sieves were used in this assessment as were used in Section 8 ANALYSIS BY MTO CRITERIA - REDUCED NUMBER OF SIEVES. A detailed assessment is given in Appendix C and a summary of the results is given below:

1. 36 lots representing 9.23% of the total were determined as being rejectable.

2. 135 lots representing 34.6% of the total would have been paid at the full contract price.

3. The average pay factor for all the non-rejectable lots was 0.930.

The projected cost implications had the proposed schemes been applied to the total quantity of hot mix placed on Ministry contracts in 1989 were investigated. Based on an average price of hot mix of $40 per tonne, the costs were calculated as follows:

Scheme Summary	Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
ASTM Tolerances - all sieves				
Feb. 1989 Procedure	$6,813,120	$3,751,082	$10,564,202	$7.00
ASTM Tolerances - reduced sieves				
Feb. 1989 Procedure	$5,574,920	$3,837,755	$9,412,675	$6.23

17 SUMMARY OF COST IMPLICATIONS

The formula described in Section 9 (above) was applied to the data derived using ASTM criteria to assess the effect of smoothing the total adjustment point vs. pay factor relationship. In addition, formulae, similar to that derived for a pay factor cut-off of 0.26 and described in Section 9 (above), were used to determine the effect of increasing the pay factor cut-off value from 0.26 to 0.50, 0.60 and 0.70. The results of these evaluations is given in the following table:

Scheme Summary		Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
ASTM Tolerances - all sieves					
Feb. 1989 Procedure		$6,813,120	$3,751,082	$10,564,202	$7.00
Calculated Pay Factor with Cut-Off of:	0.26	$6,813,120	$3,215,213	$10,028,333	$6.64
	0.50	$6,813,120	$2,143,475	$8,956,595	$5.93
	0.60	$6,813,120	$1,714,780	$8,527,900	$5.65
	0.70	$6,813,120	$1,286,085	$8,099,205	$5.36

Scheme Summary		Cost of Rejectable Mix	Cost of Borderline Mix	Total Cost	Average Cost/t
ASTM Tolerances - reduced sieves					
Feb. 1989 Procedure		$5,574,920	$3,837,755	$9,412,675	$6.23
Calculated Pay Factor with Cut-Off of:	0.26	$5,574,920	$2,741,254	$8,316,174	$5.51
	0.50	$5,574,920	$1,809,228	$7,384,148	$4.89
	0.60	$5,574,920	$1,480,277	$7,055,197	$4.67
	0.70	$5,574,920	$1,096,502	$6,671,422	$4.42

18 DISCUSSION

18.1 TOLERANCE CRITERIA

It was suggested in the consultant's report that the acceptance scheme be based on the tolerances in ASTM D3515 rather than the MTO criteria. The acceptance scheme has been developed based on the MTO criteria. Consequently it is recommended that these tolerances be retained. A major revision of the scheme and reassessment of its impact would be required if a change of this magnitude were contemplated. The MTO criteria were developed following the monitoring of 13 contracts in Ontario during the 1984 construction season where random sampling provided statistically valid information to determine the expected variability in test data. If, in the future, it is found that the tolerances are too lenient, consideration could be given to adopting the ASTM criteria instead. The consultant's recommendation to use the same tolerance limits for all mix types should be adopted. Not only does this make sound technical sense for the reasons put forward by the consultant but it also makes the proposed scheme much easier to use in the field.

18.2 CALCULATION OF PAY FACTORS

The consultants suggested that the stepped Table used for the determination of the pay factor was inequitable and could lead to dispute. The formula developed for the derivation of the Pay Factor from the Total Adjustment Points appeared to provide acceptable duplication of the values in the Table, but the severe financial implications of small changes in the adjustment points when their value was large made the use of the formula questionable. The linear relationship was therefore developed. It is believed that the use of this relationship will eliminate the problems highlighted in the consultant's report. Its use also removes any problems of interpretation for the Ministry staff. Formulae for the two lines were developed which will lend themselves readily to computer calculations, thus anticipating probable future developments.

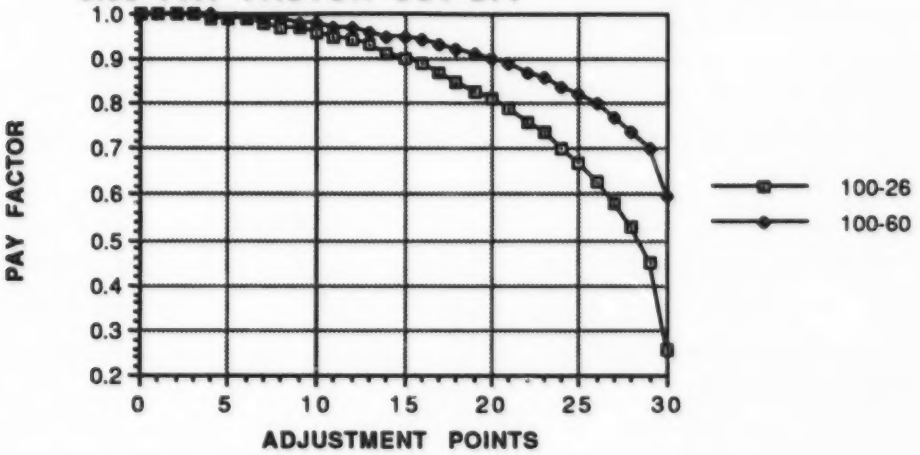
18.3 PAYMENT CUT-OFF VALUE

It was recommended by one of the consultants that the range of permitted pay factors was too large. The payment cut-off value of 0.26 was initially picked in order to prevent likely arguments over test results and address the severe financial implications of deciding whether a lot is barely rejectable or barely acceptable but with a severe price penalty. A further evaluation of the scheme suggested that these objectives would not be realized and, following the consultants' reports, it was decided to raise

the pay factor cut-off value. A cut-off value of 0.60 is proposed. Not only is this value in the middle of the range suggested by the consultant but it also allows a penalty in excess of the contractor's profit margin to be applied for large accumulations of total adjustment points.

Fig. 4 compares the pay factor versus total adjustment points relationship with cut-offs of 0.26 and the proposed 0.60.

FIG. 4 PAYMENT ADJUSTMENT CURVES
0.60 PAY FACTOR CUT-OFF



18.4 NUMBER OF SIEVES

The consultants recommended that the number of sieves on which adjustment points are assessed should be reduced. Because the Ministry uses a number of mix types with different maximum coarse aggregate sizes it would be necessary, if the number of sieves were reduced, to have different systems with a variety of coarse aggregate combinations for each mix. This would make the scheme unnecessarily complex and would invariably lead to error in its use. The consultants commented that "....the gradation of the aggregate on one sieve usually is dependent, in part, on the gradation of the aggregate on the next largest sieve." However, keeping the adjustment points value on each sieve relatively small will have the same effect as having larger adjustment points values on a fewer number of sieves. It is therefore recommended that the number of sieves on which assessment is made should not be reduced.

18.5 REJECTABLE LOTS

It is not the intention that all material in lots that are identified as rejectable always has to be removed. This is not in the contractor's or the Ministry's best interest. Rejected lots can be divided into two categories as follows:

1. If it is determined by the Engineer that the lot can remain in the work without repair then the price adjustment will be the product of:

   lot quantity x price x pay factor x contract year reduction factor

   The pay factor will be determined from the adjustment point versus pay factor straight line graph (Figure 3) by extending the line down to a minimum pay factor of 0.50. Under no circumstances will the pay factor be lower than 0.50. However, in lieu of the price adjustment, the contractor may repair the lot and the lot will be re-decisioned after the repairs are completed.

2. If it is determined by the Engineer that the lot requires repair by removal, replacement or, where permitted, by covering with an overlay, no payment will be made for the quantity of material that is removed or overlaid. After the repairs are completed the lot will be re-decisioned.

18.6 START-UP PROCEDURE

It is considered desirable to allow some leniency in the acceptance procedure at the start of mix production in order to allow time for plant adjustments to be made. It is therefore proposed that the first 500 t of hot mix produced for the item will be considered as a lot and will not be subject to a price adjustment unless the mix is rejectable. When the mix in the first 500 t lot is rejectable, the normal criteria for rejection, remedial action and price adjustment should apply.

18.7 SMALL TONNAGES

The proposed acceptance and price adjustment system was developed for use where the quantities of each item of hot mix are in excess of 2000 t. By reducing the size of the sub-lot to less than the standard 500 t it will be possible to use the scheme where the item quantity is less than 2000 t but when the quantity is very small, say less than 500 t, this is no longer feasible. It is proposed that, when the quantity is less than 500 t, the amount of testing will be established by the Engineer based upon individual circumstances. The price adjustment will still apply under certain circumstances.

18.8 PHASE-IN OF THE SYSTEM

When the proposed scheme is introduced, consideration should be given to applying only a percentage of the final pay factors in order to gradually introduce the contractors to the impacts of the new scheme. For example, the first year could impose 10% of the final price penalty. This could be increased the following year to 50%, with 100% finally being applied in the third year. An estimate has been made of the projected cost to the contracting industry of introducing the scheme. There are a large number of scenarios that could be considered, dependent on the quantity of rejectable material that is allowed to remain in the work without remedial action be required. The first year cost implications of two of these scenarios have been evaluated:

Scenario 1

All rejectable material remains in the work with no remedial action required:

Borderline cost:	10% x $995,277	=	$99,528
Rejectable cost:	10% x $1,854,280 x 0.5	=	$92,714
Total cost:		=	$145,405

Scenario 2

1 sublot within 50% of the rejectable lots is repaired. The remaining 50% are left in the work with no remedial action required. The repaired sublot and remaining three sublots are acceptable:

Borderline cost:	10% x $995,277	=	$99,528
Rejectable cost:	10% x $1,854,280 x 0.5 x 0.5	=	$46,357
	0.25 x $1,854,280 x 0.5	=	$463,570
Total cost:		=	$563,098

The actual price reductions for material rejectable by testing applied in 1989 under the existing B-138 acceptance procedure amounted to $122,166 on approximately $60,000,000 worth of hot mix placed on Ministry contracts in 1989.

19 RECOMMENDATIONS

The Ministry intends to adopt the following scheme and introduce it on all contracts as soon as possible.

1. The Table of tolerances and adjustment points in the February 1989 Draft of the special provision Acceptance and Price Adjustment based on Aggregate Gradation and Asphalt Cement Content should form the basis of the scheme.

2. Adjustment points will be determined for Mean and Range requirements based on MTO criteria. The same tolerance limits will be used for all mixes.

3. The criteria will consist of the asphalt cement content and all sieves.

4. The adjustment points will be used to determine the pay factor for the lot of the item in accordance with the following formulae:

   if $P \leq 20$; Pay Factor = $1 - (P \times 0.005)$

   if $P > 20$; Pay Factor = $0.9 - [(P-20) \times 0.03]$

   where P = Total Adjustment Points

N. B. In the special provision the adjustment points will be used to determine a Payment Reduction Factor rather than a Pay Factor.

5. The pay factor cut-off value should be set at 0.60. Below this value the material should be considered as rejectable and the appropriate action taken.

6. The price reduction should be reduced initially to 10% of its final value for 90- and 91-numbered contracts. This should be increased to 50% for 92-numbered contracts with full implementation in 1993.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		MEAN OUT LIMIT	(n=4)	10.30	15.0	15.0	15.0	15.0	15.0	15.0	14.5	14.0	13.5	13.0	12.5	12.0		
2		MEAN OUT LIMIT	(n=5)	10.27	14.5	14.5	14.5	14.5	14.5	14.0	13.6	13.1	12.7	12.2	11.8			
3		MEAN OUT LIMIT	(n=6)	10.25	14.1	14.1	14.1	14.1	14.1	13.7	13.2	12.8	12.5	12.0	11.6			
4		MEAN OUT LIMIT	(n=7)	10.23	13.8	13.8	13.8	13.8	13.8	13.4	13.0	12.5	12.2	11.8	11.5			
5																		
6			RANGE LIMIT	0.60	10	10	10	10	10	10	8	8	7	6	5	4		
7																		
8	CONTRACT	89-44																
9	MIX TYPE	RECYCLE25/75																
10																		
11			CUMULA.	AC	28.5	19.0	15.0	13.7	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075	TOTAQUPTS	PAYFACTOR
12	LOT NUMBER	SUB-LOT	TARGET =	8.70	0.0	0.0	0.0	0.3	10.7	30.0	53.5	55.8	62.7	80.7	94.3	98.8		
13																		
14	4	1		8.85	0	0	0	0.7	10.5	31.2	55.8	58	65.3	80.2	93.3	96.9		
15		2		8.78	0	0	0	0	10.2	31.4	55.1	57.3	64.8	80.9	94.4	98.8		
16		3		8.29	0	0	0	0	22.9	54	56.8	59.8	66	80.2	93.4	96.8		
17		4		8.83	0	0	0	0	10.1	49	52.8	56.2	62.8	80.5	93.8	98		
18																		
19			MEAN	8.68	0.00	0.00	0.00	0.18	10.43	31.40	55.38	57.93	64.99	80.48	93.68	97.10		
20			MEAN OUT	0.039	0.000	0.000	0.000	0.125	0.275	1.400	1.875	1.725	1.275	0.825	0.725			
21			MIN.	8.29	0.00	0.00	0.00	0.00	10.10	49.00	52.80	56.20	62.80	80.20	93.30	96.80		
22			MAX.	8.83	0.00	0.00	0.00	0.70	22.90	54.00	59.80	59.80	66.00	80.90	94.40	98.80		
23			RANGE	0.54	0.00	0.00	0.00	0.70	4.80	5.00	7.00	3.60	3.20	0.70	1.10	1.00		
24																		
25			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
26			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
27			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
28																		
29	5	1		5.98	0	0	0	0.2	17.4	50.1	54.7	57	63.8	80	93.3	97		
30		2		5.77	0	0	0	0.4	18.1	48.1	50.8	53	60.7	80.4	93.5	97		
31		3		5.81	0	0	0	0	16.8	47	52.8	55.2	62.7	80.6	93.9	97.2		
32		4		5.41	0	0	0	0	18.5	50.8	54.8	57.1	65.2	80.2	93.4	97.8		
33																		
34			MEAN	5.73	0.00	0.00	0.00	0.10	17.10	48.50	53.20	55.80	63.13	80.20	93.60	97.03		
35			MEAN OUT	0.025	0.000	0.000	0.000	0.125	2.525	1.000	0.225	0.700	0.475	1.400	0.700	0.075		
36			MIN.	5.41	0.00	0.00	0.00	0.00	16.80	46.10	52.80	55.20	62.70	80.20	93.40	96.80		
37			MAX.	5.98	0.00	0.00	0.00	0.20	18.50	50.80	54.80	57.10	65.20	80.60	93.90	97.20		
38			RANGE	0.29	0.00	0.00	0.00	0.20	4.00	4.70	4.00	4.10	4.50	0.40	0.50	0.30		
39																		
40			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
41			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
42			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
43																		
44	6	1		5.76	0	0	0	0.5	17.9	48.1	52.4	54.8	64	87.5	91.8	93.8		
45		2		5.50	0	0	0	0.2	17.4	48.7	53.7	56	65.8	88.4	92.7	95.2		
46		3		5.22	0	0	0	0.5	18.5	51.8	56.5	58.7	66.8	89.5	94	95.6		
47		4		5.67	0	0	0	0	12.3	45.3	50.5	52.8	61.4	87.7	92.3	94		
48																		
49			MEAN	5.57	0.00	0.00	0.00	0.30	16.73	48.49	53.28	55.93	64.42	88.53	92.98	94.80		
50			MEAN OUT	0.135	0.000	0.000	0.000	0.000	2.975	1.600	0.225	0.275	1.725	2.175	1.925	1.300		
51			MIN.	5.22	0.00	0.00	0.00	0.00	12.30	45.30	50.50	52.80	61.40	87.50	91.80	93.80		
52			MAX.	5.76	0.00	0.00	0.00	0.50	19.50	51.80	56.50	58.70	66.80	89.50	94.00	95.60		
53			RANGE	0.43	0.00	0.00	0.00	0.50	7.00	6.20	6.00	5.80	5.40	2.00	2.10	1.80		
54																		
55			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
56			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
57			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 1 Example Calculation Sheet
Acceptable Material Receiving Full Payment

	A	B	C	D	E	F	G	H	(88-228-030)		K	L	M	N	O	P	Q	R
1		MEAN OUT LIMIT	(n=4)	±0.30	±5.0	±5.0	±5.0	±5.0	±5.0	±5.0	±4.5	±4.0	±3.5	±3.-	±2.5	±2.0		
2		MEAN OUT LIMIT	(n=5)	±0.27	±4.5	±4.5	±4.5	±4.5	±4.5	±4.5	±4.0	±3.6	±3.1	±2.7	±2.2	±1.8		
3		MEAN OUT LIMIT	(n=6)	±0.23	±4.1	±4.1	±4.1	±4.1	±4.1	±4.1	±3.7	±3.3	±2.8	±2.5	±2.0	±1.6		
4		MEAN OUT LIMIT	(n=7)	±0.22	±3.8	±3.8	±3.8	±3.8	±3.8	±3.8	±3.4	±3.0	±2.6	±2.3	±1.8	±1.5		
5																		
6			RANGE LIMIT	0.60	10	10	10	10	10	10	9	8	7	6	5	4		
7																		
8	CONTRACT	88-228-030																
9	MIX TYPE	HL4 PWM																
10																		
11			CRITERIA •	AC	76.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075	TOT ADJ PTS	PAY FACTOR
12	LOT NUMBER	SUB-LOT	TARGET •	5.29	9.0	9.0	9.2	4.8	28.8	39.8	36.0	60.7	68.4	78.0	91.1	96.5		
13																		
14	1	1		5.52	0	0	2.4	6.8	26.2	44.1	36.6	58.7	62.2	74.7	86.7	93.1		
15		2		5.18	0	0	1.8	8.5	25.0	46.6	38.0	56.2	62.4	76.6	88.6	93.5		
16		3		5.48	0	0	2.7	7.2	23.5	44.8	31.1	58.5	63.6	76.3	89.8	93.4		
17		4		5.42	0	0	2.4	6.8	24.0	42.6	40.8	55	62.2	74.7	88.2	93		
18																		
19			MEAN	5.40	0.00	0.00	2.32	7.78	28.13	44.03	30.33	35.85	62.88	75.58	89.10	93.25		
20			MEAN OUT	0.186	0.000	0.000	2.025	2.975	1.775	5.875	8.475	4.850	3.525	2.425	2.000	1.250		
21			MIN.	5.18	0.00	0.00	1.80	6.80	22.80	42.80	40.30	55.00	62.20	74.70	88.20	93.00		
22			MAX.	5.52	0.00	0.00	2.70	8.80	26.20	46.80	31.10	58.50	63.60	76.60	89.80	95.50		
23			RANGE	0.32	0.00	0.00	0.90	2.20	3.70	2.20	1.80	1.50	1.40	1.90	1.80	0.30		
24																		
25			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.05	0.02	0.00	0.00	0.00		
26			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
27			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.05	0.02	0.00	0.00	0.00	0.75	0.97
28																		
29	2	1		5.18	0	0	0	10.7	28.2	44.0	31.7	56.7	62.8	76.5	89.2	93.2		
30		2		5.24	0	1.3	2	7.8	17.2	48	31.7	57.1	64	78.2	89.2	93.2		
31		3		5.44	0	0	0.8	7.1	23.1	41.8	46.7	54.8	62.2	75	88.7	93		
32		4		5.59	0	0	0.6	10.4	28.4	45.7	32.6	58.4	66.2	78.7	90.4	93.-		
33																		
34			MEAN	5.38	0.00	0.32	0.85	9.00	24.50	44.18	31.98	56.75	64.05	76.82	89.38	93.22		
35			MEAN OUT	0.188	0.000	0.325	0.950	4.200	2.400	5.825	4.950	3.950	2.350	1.375	1.725	1.275		
36			MIN.	5.18	0.00	0.00	0.00	7.10	17.20	41.80	46.70	54.80	62.20	75.00	88.70	93.00		
37			MAX.	5.59	0.00	1.30	2.00	10.70	28.20	45.70	32.60	58.40	66.20	78.70	90.40	93.50		
38			RANGE	0.40	0.00	1.30	2.00	3.60	11.00	4.20	2.90	3.60	4.00	3.70	1.70	0.50		
39																		
40			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	4.13	0.45	0.00	0.00	0.00	0.00	0.00		
41			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
42			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	2.80	4.13	0.45	0.00	0.00	0.00	0.00	0.00	0.38	0.96
43																		
44	3	1		5.14	0	0	2.8	5.6	17.8	46.8	33.6	58.4	66.8	77.7	88.6	94.8		
45		2		5.28	0	0	1.5	8.8	26.8	46.1	32.8	58.3	66.8	77.9	88.6	93.3		
46		3		5.38	0	0	1.4	8	24.1	45.2	32.4	58.8	66.1	77.7	88.2	93.1		
47		4		5.41	0	0	1.2	7.5	26.2	46.7	33.3	59.2	66.5	77.6	88.2	93		
48																		
49			MEAN	5.30	0.00	0.00	1.73	6.93	23.73	46.20	33.23	58.10	66.48	77.73	88.15	94.05		
50			MEAN OUT	0.099	0.000	0.000	1.475	2.125	3.150	3.000	2.775	1.600	0.950	0.275	1.950	1.825		
51			MIN.	5.14	0.00	0.00	1.20	5.60	17.80	45.20	32.40	58.30	66.10	77.60	88.60	94.30		
52			MAX.	5.41	0.00	0.00	2.80	8.80	26.90	46.80	33.60	58.40	66.60	77.90	89.60	93.30		
53			RANGE	0.27	0.00	0.00	1.60	3.20	9.10	1.60	1.20	0.80	0.50	0.30	1.00	0.80		
54																		
55			MEAN ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
56			RANGE ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
57			TOTAL ADJ.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 2 Example Calculation Sheet Borderline Material Receiving Reduced Payment

	A	B	C	D	E	F	G	H	I&S-0&7-01J		K	L	M	N	O	P	Q	R
1		MEAN QUT LIMIT (n=4)		10.20	17.0	17.0	17.0	17.0	17.0	17.0	16.0	15.0	14.5	14.0	13.0	12.0		
2		MEAN QUT LIMIT (n=5)		10.27	16.2	16.2	16.2	16.2	16.2	16.2	15.4	14.5	14.0	13.6	12.7	11.8		
3		MEAN QUT LIMIT (n=6)		10.25	15.7	15.7	15.7	15.7	15.7	15.7	14.9	14.1	13.7	13.2	12.5	11.6		
4		MEAN QUT LIMIT (n=7)		10.23	15.3	15.3	15.3	15.3	15.3	15.3	14.5	13.8	13.4	13.0	12.3	11.5		
5																		
6			RANGE LIMIT	0.80	14	14	14	14	14	14	12	10	9	8	6	4		
7																		
8	CONTRACT	88-07																
9	MIX TYPE	HLC HD																
10																		
11			CRITERIA >	AC	26.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075	TOT ADJ PTS	PAY FACTOR
12	LOT NUMBER	SUB-LOT	TARGET =	3.00	0.0	4.0	14.0	28.7	55.0	92.2	100.0	100.0	100.0	100.0	100.0	97.0		
13																		
14	1	1		2.94	0	8.2	24.5	41.7	67.7	90.5	93.7	100	100	100	100	98.8		
15		2		3.00	0	6.8	21.1	38.7	66.5	89.4	92.6	94.8	95.3	95.6	95.9	98.0		
16		3		3.04	0	8	21.7	33.8	62.5	90.8	93.7	94.8	96.3	95.5	95.8	98.5		
17		4		3.04	0	2.7	14.3	27.3	58.6	88	93.1	95	95.5	95.8	96.1	98.7		
18																		
19			MEAN	3.01	0.00	5.93	20.35	35.38	61.83	89.92	93.53	96.15	96.53	96.73	96.95	98.73		
20			MEAN QUT	0.005	0.000	1.050	6.350	6.675	6.825	2.275	6.475	3.850	3.475	3.775	3.050	1.175		
21			MIN.	2.94	0.00	2.70	14.30	27.30	58.60	88.00	92.10	94.80	95.30	95.50	95.80	98.50		
22			MAX.	3.04	0.00	8.20	24.30	41.70	67.70	93.70	93.70	100.00	100.00	100.00	100.00	98.90		
23			RANGE	0.10	0.00	5.50	10.00	14.40	17.10	7.80	0.60	5.20	4.70	4.50	4.20	0.40		
24																		
25			MEAN ADJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.10	0.00		
26			RANGE ADJ	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
27			TOTAL ADJ	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.48	0.00	0.00	0.00	0.10	0.00	7.88	0.79
28																		
29	2	1		2.78	0	16	37.5	51.8	71.4	91.6	94.5	95.5	95.8	95.9	96.3	97		
30		2		2.84	0	6.8	27.8	37.8	65.2	91.2	94.6	95.6	96	96.2	96.5	97		
31		3		2.84	0	7.2	26.7	38.5	64.7	91	94.2	95.2	95.5	95.7	96	96.7		
32		4		3.00	0	6.8	13.9	23.2	59.5	90.7	94	95.1	95.5	95.8	96.1	96.8		
33																		
34			MEAN	2.94	0.00	9.20	26.43	36.55	65.23	91.13	94.30	95.35	95.70	95.90	96.23	96.68		
35			MEAN QUT	0.065	0.000	4.300	12.425	8.650	10.225	1.075	3.700	4.650	4.300	4.100	3.775	1.025		
36			MIN.	2.78	0.00	6.80	13.90	23.20	59.50	90.70	94.00	95.10	95.50	95.70	96.00	96.70		
37			MAX.	3.04	0.00	16.00	37.30	51.80	71.40	91.60	94.50	95.60	96.00	96.20	96.50	97.00		
38			RANGE	0.30	0.00	9.20	23.40	28.70	11.90	0.90	0.50	0.50	0.50	0.50	0.50	0.30		
39																		
40			MEAN ADJ	0.00	0.00	0.00	0.43	2.65	2.22	0.00	0.00	0.00	0.00	0.20	1.88	0.00		
41			RANGE ADJ	0.00	0.00	0.00	18.80	25.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
42			TOTAL ADJ	0.00	0.00	0.00	24.22	28.05	2.22	0.00	0.00	0.00	0.00	0.20	1.88	0.00	97.25	R
43																		
44	3	1		2.84	0	7.8	17.8	30.2	73.4	93.2	95.3	96.1	96.4	96.6	96.8	97.3		
45		2		2.82	0	12.4	24.1	42.9	68.8	91.6	94.2	95.2	95.7	96	96.2	97.9		
46		3		2.88	0	4.6	13.8	23.1	70.7	91.8	93.6	94.9	95	95.4	96.2	97.1		
47		4		2.90	0	7.2	35.5	52.9	80.4	91.4	92.8	93.8	94.1	94.5	96.4	96.4		
48																		
49			MEAN	2.89	0.00	8.00	22.73	42.53	73.33	92.00	93.95	94.68	95.30	95.63	96.15	96.93		
50			MEAN QUT	0.410	0.000	2.100	8.725	13.925	18.325	0.700	0.850	0.925	0.700	0.575	0.850	0.975		
51			MIN.	2.80	0.00	4.60	13.80	28.20	68.80	91.40	92.80	93.80	94.10	94.30	93.40	96.40		
52			MAX.	2.84	0.00	12.40	35.50	52.90	80.40	92.20	95.30	96.10	96.40	96.60	96.80	97.30		
53			RANGE	0.14	0.00	7.80	22.00	23.70	11.60	1.80	2.70	2.50	2.30	2.10	1.40	0.90		
54																		
55			MEAN ADJ	0.00	0.00	0.00	1.73	6.63	11.33	0.00	0.05	0.13	0.40	0.75	1.70	0.00		
56			RANGE ADJ	0.00	0.00	0.00	16.00	19.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
57			TOTAL ADJ	0.00	0.00	0.00	17.73	26.22	11.33	0.00	0.05	0.13	0.40	0.75	1.70	0.00	97.19	R

Table 3 Example Calculation Sheet Rejectable Material

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO CRITERIA		REDUCED SIEVES		ASTM CRITERIA		REDUCED SIEVES		Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
87-060	DFC	87-060-05	1	15.20	0.87	9.40	0.95	27.58	0.41	17.78	0.80	Central
87-075	HL-3	87-075-02	1	0.00	1.00	0.00	1.00	1.83	1.00	1.63	1.00	Central
87-075	DFC	87-075-03	1	5.78	0.98	3.63	0.99	10.48	0.94	7.33	0.97	Central
87-076	DFC	87-076-04	1	11.20	0.93	11.20	0.93	17.20	0.82	17.20	0.82	Central
	DFC	87-076-04	2	0.00	1.00	0.00	1.00	4.00	0.99	4.00	0.99	
	DFC	87-076-04	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
87-076	DFC	87-076-07	1	0.00	1.00	0.00	1.00	0.00	1.00	1.60	1.00	Central
	DFC	87-076-07	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	DFC	87-076-07	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
87-076	HL-8	87-076-01	1	0.00	1.00	0.00	1.00	18.55	0.80	18.35	0.79	Central
	HL-8	87-076-01	2	1.30	1.00	1.30	1.00	19.85	0.75	18.40	0.79	
	HL-8	87-076-01	3	7.90	0.96	7.90	0.96	43.25	R	39.95	R	
	HL-8	87-076-01	4	0.78	1.00	0.78	1.00	16.04	0.85	14.36	0.88	
	HL-8	87-076-01	5	16.40	0.84	15.40	0.86	62.10	R	48.7	R	
	HL-8	87-076-01	6	1.85	1.00	1.85	1.00	14.26	0.88	12.33	0.91	
	HL-8	87-076-01	7	34.68	R	34.38	R	99.63	R	84.38	R	
	HL-8	87-076-01	8	1.85	1.00	1.65	1.00	10.00	0.94	7.9	0.96	
	HL-8	87-076-01	9	0.00	1.00	0.00	1.00	16.68	0.85	15.03	0.87	
	HL-8	87-076-01	10	1.30	1.00	1.30	1.00	7.05	0.97	5.7	0.98	
87-092	DFC	87-092-01	1	0.30	1.00	0.15	1.00	3.25	0.99	2.10	1.00	Central
	DFC	87-092-01	2	29.00	1.00	0.28	1.00	2.15	1.00	1.78	1.00	
	DFC	87-092-01	3	1.20	1.00	1.20	1.00	11.43	0.93	11.43	0.93	
	DFC	87-092-01	4	0.65	1.00	0.65	1.00	3.03	0.99	2.55	0.99	
87-092	DFC	87-092-14	1	8.50	0.95	8.10	0.96	21.60	0.70	20.20	0.75	Central
	DFC	87-092-14	2	11.72	0.92	11.04	0.93	21.22	0.71	19.54	0.76	
	DFC	87-092-14	3	0.40	1.00	0.40	1.00	6.53	0.98	6.50	0.98	
87-229	HL-4	87-229-20	1	0.00	1.00	0.00	1.00	10.33	0.94	10.33	0.94	Northern
	HL-4	87-229-20	2	8.63	0.95	7.00	0.97	12.98	0.90	11.35	0..93	
88-014	HL-4	88-014-10	1	0.00	1.00	0.00	1.00	0.60	1.00	0.50	1.00	Eastern
88-014	HL-4	88-014-20	1	0.23	1.00	0.23	1.00	4.33	0.99	4.33	0.99	Eastern
	HL-4	88-014-20	2	3.60	0.99	3.60	0.99	6.80	0.98	5.85	0.98	
	HL-4	88-014-20	3	0.00	1.00	0.00	1.00	2.85	0.99	2.85	0.99	
88-014	DFC	88-014-30	1	13.48	0.89	9.48	0.95	42.45	R	32.45	R	Eastern
	DFC	88-014-30	2	1.63	1.00	1.38	1.00	8.93	0.95	7.43	0.97	
	DFC	88-014-30	3	2.25	1.00	2.25	1.00	7.83	0.96	6.93	0.97	
	DFC	88-014-30	4	3.38	0.99	3.38	0.99	16.13	0.85	15.53	0.86	

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
88-014	HL-4 HD	88-014-60	1	3.84	0.99	3.84	0.99	7.20	0.97	7.20	0.97	Eastern
	HL-4 HD	88-014-60	2	0.00	1.00	0.00	1.00	4.05	0.99	4.05	0.99	
	HL-4 HD	88-014-60	3	0.00	1.00	0.00	1.00	14.65	0.88	12.75	0.91	
88-021	FHM	88-021-02	1	1.30	1.00	1.30	1.00	6.45	0.98	6.15	0.98	Southwestern
	FHM	88-021-02	2	3.25	0.99	3.25	0.99	11.25	0.93	11.25	0.93	
	FHM	88-021-02	3	0.00	1.00	0.00	1.00	4.70	0.99	4.70	0.99	
	FHM	88-021-02	4	0.00	1.00	0.00	1.00	2.25	1.00	2.25	1.00	
	FHM	88-021-02	5	0.00	1.00	0.00	1.00	2.55	1.00	2.55	1.00	
	FHM	88-021-02	6	0.00	1.00	0.00	1.00	2.05	1.00	2.05	1.00	
	FHM	88-021-02	7	0.00	1.00	0.00	1.00	2.00	1.00	2.00	1.00	
	FHM	88-021-02	8	0.00	1.00	0.00	1.00	0.40	1.00	0.40	1.00	
	FHM	88-021-02	9	0.00	1.00	0.00	1.00	1.25	1.00	1.25	1.00	
	FHM	88-021-02	10	0.00	1.00	0.00	1.00	2.00	1.00	2.00	1.00	
	FHM	88-021-02	11	3.20	0.99	3.20	0.99	17.40	0.81	15.80	0.85	
	FHM	88-021-02	12	0.00	1.00	0.00	1.00	1.65	1.00	1.65	1.00	
88-025	HL-4	88-025-10	1	0.00	1.00	0.00	1.00	5.68	0.98	5.38	0.99	Eastern
	HL-4	88-025-10	2	0.00	1.00	0.00	1.00	4.85	0.99	4.45	0.99	
88-026	FHM	88-026-20	1	14.40	0.88	8.60	0.95	26.60	0.50	18.80	0.77	Eastern
	FHM	88-026-20	2	9.80	0.94	5.50	0.99	18.05	0.80	11.75	0.92	
	FHM	88-026-20	3	12.15	0.92	8.25	0.96	14.23	0.88	9.25	0.95	
	FHM	88-026-20	4	12.68	0.91	8.55	0.96	18.16	0.80	12.03	0.92	
	FHM	88-026-20	5	13.90	0.88	10.20	0.94	17.88	0.82	12.18	0.92	
	FHM	88-026-20	6	21.75	0.69	19.40	0.76	28.65	0.36	24.70	0.57	
	FHM	88-026-20	7	17.35	0.82	13.60	0.89	20.70	0.75	15.95	0.85	
	FHM	88-026-20	8	18.80	0.78	15.80	0.85	27.40	0.44	23.40	0.62	
88-026	HL-4	88-026-40	1	4.25	0.99	4.25	0.99	6.23	0.98	6.00	0.98	Eastern
	HL-4	88-026-40	2	6.74	0.97	6.74	0.97	13.74	0.90	13.74	0.89	
	HL-4	88-026-40	3	17.70	0.81	17.70	0.81	24.95	0.60	24.70	0.57	
88-048	HL-8 HD	88-048-01	1	0.20	1.00	0.20	1.00	25.34	0.55	16.93	0.82	Central
	HL-8 HD	88-048-01	2	0.68	1.00	0.68	1.00	10.03	0.94	7.63	0.96	
	HL-8 HD	88-048-01	3	4.59	0.99	3.44	0.99	19.14	0.77	13.89	0.88	
	HL-8 HD	88-048-01	4	10.80	0.93	9.00	0.95	47.03	R	34.40	R	
88-067	DFC	88-067-04	1	1.95	1.00	1.95	1.00	4.95	0.99	4.95	0.99	Central
	DFC	88-067-04	2	5.26	0.99	5.26	0.99	10.78	0.94	9.58	0.94	
	DFC	88-067-04	3	4.93	0.99	4.93	0.99	8.48	0.96	8.48	0.96	
	DFC	88-067-04	4	1.65	1.00	1.65	1.00	5.90	0.99	5.90	0.98	
	DFC	88-067-04	5	3.68	0.99	3.68	0.99	7.61	0.97	6.66	0.97	
	DFC	88-067-04	6	0.83	1.00	0.83	1.00	4.68	0.99	4.68	0.99	
	DFC	88-067-04	7	2.23	1.00	2.23	1.00	4.33	0.99	4.33	0.99	
	DFC	88-067-04	8	1.93	1.00	1.93	1.00	6.23	0.98	6.23	0.98	

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
88-067	OPC	88-067-07	1	6.13	0.98	4.78	0.99	13.43	0.90	11.08	0.93	Central
	OPC	88-067-07	2	0.08	1.00	0.08	1.00	2.58	0.99	2.58	0.99	
	OPC	88-067-07	3	1.20	1.00	1.20	1.00	9.80	0.95	9.80	0.94	
	OPC	88-067-07	4	0.00	1.00	0.00	1.00	9.40	0.95	9.40	0.95	
	OPC	88-067-07	5	2.85	0.99	2.85	0.99	5.35	0.99	5.35	0.99	
88-067	HL-8 HD	88-067-01	1	7.58	0.96	6.68	0.97	54.54	R	37.31	R	Central
	HL-8 HD	88-067-01	2	57.25	R	27.65	0.39	112.21	R	65.26	R	
	HL-8 HD	88-067-01	3	67.10	R	39.05	R	98.43	R	61.20	R	
	HL-8 HD	88-067-01	4	25.48	0.53	14.60	0.87	79.07	R	49.51	R	
	HL-8 HD	88-067-01	5	1.75	1.00	1.40	1.00	23.48	0.64	17.45	0.81	
	HL-8 HD	88-067-01	6	70.50	R	47.45	R	125.44	R	84.74	R	
	HL-8 HD	88-067-01	7	131.53	R	71.75	R	197.07	R	106.73	R	
	HL-8 HD	88-067-01	8	31.58	R	26.55	0.47	79.98	R	54.05	R	
88-067	HL-8 HD	88-067-03	1	6.35	0.98	6.20	0.98	52.94	R	40.59	R	Central
	HL-8 HD	88-067-03	2	6.80	0.97	6.80	0.97	24.90	0.60	23.00	0.64	
	HL-8 HD	88-067-03	3	0.00	1.00	0.00	1.00	2.90	0.99	2.90	0.99	
	HL-8 HD	88-067-03	4	4.45	0.99	3.60	0.99	31	R	22.55	0.66	
	HL-8 HD	88-067-03	5	2.80	0.99	2.80	0.99	52.44	R	39.86	R	
	HL-8 HD	88-067-03	6	5.65	0.98	4.20	0.98	21.63	0.71	18.18	0.8	
	HL-8 HD	88-067-03	7	33.90	R	25.55	0.52	121.00	R	93.65	R	
	HL-8 HD	88-067-03	8	6.10	0.98	4.60	0.99	29.13	R	21.83	0.68	
	HL-8 HD	88-067-03	9	19.65	0.76	17.55	0.81	79.85	R	75.55	R	
88-067	HL-8	88-067-05	1	1.15	1.00	0.75	1.00	44.36	R	27.78	0.38	Central
88-071	RHM	88-071-01	1	0.00	1.00	0.00	1.00	4.75	0.99	4.75	0.99	Southwestern
	RHM	88-071-01	2	0.00	1.00	0.00	1.00	5.00	0.99	5.00	0.99	
	RHM	88-071-01	3	0.00	1.00	0.00	1.00	7.25	0.97	7.25	0.97	
	RHM	88-071-01	4	0.00	1.00	0.00	1.00	3.25	0.99	3.25	0.99	
	RHM	88-071-01	5	0.00	1.00	0.00	1.00	4.75	0.99	4.75	0.99	
	RHM	88-071-01	6	0.50	1.00	0.50	1.00	5.50	0.99	5.50	0.99	
	RHM	88-071-01	7	1.38	1.00	1.38	1.00	5.88	0.98	5.88	0.98	
88-077	RHM	88-077-03	1	45.40	R	41.40	R	70.35	R	61.50	R	Central
	RHM	88-077-03	2	0.00	1.00	0.00	1.00	1.50	1.00	1.50	1.00	
	RHM	88-077-03	3	8.40	0.96	8.40	0.96	26.65	0.50	22.85	0.64	
	RHM	88-077-03	4	0.00	1.00	0.00	1.00	2.60	0.99	2.60	0.99	
	RHM	88-077-03	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	RHM	88-077-03	6	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	
	RHM	88-077-03	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	RHM	88-077-03	8	0.60	1.00	0.60	1.00	8.80	0.96	8.80	0.95	
	RHM	88-077-03	9	0.35	1.00	0.00	1.00	5.35	0.99	4.00	0.99	
	RHM	88-077-03	10	0.00	1.00	0.00	1.00	7.40	0.97	7.40	0.97	
	RHM	88-077-03	11	0.00	1.00	0.00	1.00	2.10	1.00	1.85	1.00	

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
88-079	DFC	88-079-03	1	0.00	1.00	0.00	1.00	2.25	1.00	2.25	1.00	Central
	DFC	88-079-03	2	0.00	1.00	0.00	1.00	2.20	1.00	2.20	1.00	
88-079	HL-8 HD	88-079-02	1	0.15	1.00	0.00	1.00	12.83	0.92	10.28	0.94	Central
	HL-8 HD	88-079-02	2	0.00	1.00	0.00	1.00	17.88	0.82	10.15	0.94	
	HL-8 HD	88-079-02	3	0.00	1.00	0.00	1.00	1.55	1.00	0.95	1.00	
	HL-8 HD	88-079-02	4	0.00	1.00	0.00	1.00	7.60	0.97	4.00	0.99	
	HL-8 HD	88-079-02	5	7.40	0.97	7.40	0.97	57.39	R	52.41	R	
	HL-8 HD	88-079-02	6	0.00	1.00	0.00	1.00	27.60	0.44	13.40	0.89	
	HL-8 HD	88-079-02	7	3.75	0.99	2.40	1.00	35.95	R	25.8	0.51	
	HL-8 HD	88-079-02	8	0.70	1.00	0.00	1.00	42.33	R	35.43	R	
88-086	HL-4	88-086-10	1	1.40	1.00	1.40	1.00	21.53	0.70	21.35	0.70	Eastern
	HL-4	88-086-10	2	0.25	1.00	0.25	1.00	2.35	1.00	2.25	1.00	
	HL-4	88-086-10	3	1.88	1.00	1.60	1.00	7.63	0.96	6.35	0.98	
	HL-4	88-086-10	4	6.95	0.97	6.70	0.97	36.63	R	32.18	R	
	HL-4	88-086-10	5	1.45	1.00	1.35	1.00	3.40	0.99	2.35	1.00	
88-203	R+M	88-203-10	1	21.64	0.68	21.64	0.68	43.64	R	41.84	R	Northern
	R+M	88-203-10	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R+M	88-203-10	3	0.00	1.00	0.00	1.00	14.20	0.88	13.00	0.90	
	R+M	88-203-10	4	0.00	1.00	0.00	1.00	0.40	1.00	0.40	1.00	
	R+M	88-203-10	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R+M	88-203-10	6	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R+M	88-203-10	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
88-203	R+M	88-203-20	1	1.50	1.00	1.50	1.00	3.50	0.99	3.50	0.99	Northern
	R+M	88-203-20	2	0.00	1.00	0.00	1.00	0.30	1.00	0.30	1.00	
	R+M	88-203-20	3	0.40	1.00	0.40	1.00	2.40	1.00	2.40	1.00	
	R+M	88-203-20	4	16.60	0.82	15.00	0.87	46.60	R	40.80	R	
	R+M	88-203-20	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R+M	88-203-20	6	0.00	1.00	0.00	1.00	1.35	1.00	1.35	1.00	
	R+M	88-203-20	7	0.50	1.00	0.50	1.00	10.10	0.94	10.10	0.94	
	R+M	88-203-20	8	0.00	1.00	0.00	1.00	1.83	1.00	1.83	1.00	
	R+M	88-203-20	9	0.00	1.00	0.00	1.00	3.20	0.99	3.20	0.99	
	R+M	88-203-20	10	0.35	1.00	0.35	1.00	2.25	1.00	2.25	1.00	
	R+M	88-203-20	11	1.20	1.00	1.20	1.00	3.20	0.99	3.20	0.99	
	R+M	88-203-20	12	0.60	1.00	0.60	1.00	3.80	0.99	3.80	0.99	
	R+M	88-203-20	13	0.50	1.00	0.50	1.00	2.50	1.00	2.50	1.00	
88-213	R+M	88-213-10	1	0.00	1.00	0.00	1.00	13.04	0.90	12.61	0.91	Northern
	R+M	88-213-10	2	0.00	1.00	0.00	1.00	4.40	0.99	4.40	0.99	
88-213	HL-4	88-213-11	1	15.73	0.85	13.45	0.89	29.73	R	26.45	0.47	Northern
88-226	R+M	88-226-20	1	6.75	0.97	5.90	0.98	18.75	0.78	16.90	0.82	Northern

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	FRM	88-226-20	2	8.38	0.96	8.38	0.96	24.53	0.58	23.38	0.62	
	FRM	88-226-20	3	0.00	1.00	0.00	1.00	5.95	0.98	5.95	0.98	
	FRM	88-226-20	4	0.00	1.00	0.00	1.00	3.03	0.99	2.80	0.99	
89-007	HL-4	88-007-10	1	0.83	1.00	0.00	1.00	1.83	1.00	0.40	1.00	Eastern
89-012	HL-4	89-012-10	1	0.20	1.00	0.20	1.00	8.33	0.96	8.33	0.96	Eastern
89-013	HL-4	89-013-11	1	1.70	1.00	1.60	1.00	4.20	0.99	3.60	0.99	Eastern
	HL-4	89-013-11	2	2.00	1.00	1.65	1.00	6.38	0.98	5.03	0.99	
	HL-4	89-013-11	3	9.80	0.94	7.00	0.97	10.58	0.80	8.63	0.95	
	HL-4	89-013-11	4	9.58	0.94	6.50	0.98	28.49	0.26	24.41	0.58	
	HL-4	89-013-11	5	9.33	0.95	6.25	0.98	15.09	0.87	11.01	0.93	
	HL-4	89-013-11	6	10.53	0.94	8.05	0.96	14.58	0.88	11.10	0.93	
89-017	HL-4	89-017-10	1	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	Northern
89-019	FRM	89-019-10	1	0.20	1.00	0.20	1.00	8.08	0.96	8.08	0.96	Eastern
	FRM	89-019-10	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	FRM	89-019-10	3	0.00	1.00	0.00	1.00	5.13	0.99	5.13	0.99	
	FRM	89-019-10	4	0.00	1.00	0.00	1.00	0.40	1.00	0.40	1.00	
	FRM	89-019-10	5	0.00	1.00	0.00	1.00	0.10	1.00	0.10	1.00	
	FRM	89-019-10	6	0.00	1.00	0.00	1.00	2.21	1.00	1.23	1.00	
	FRM	89-019-10	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
89-021	FRM	89-021-01	1	6.73	0.97	5.65	0.98	13.08	0.90	11.00	0.93	Central
	FRM	89-021-01	2	15.93	0.85	12.75	0.90	23.83	0.64	19.65	0.75	
	FRM	89-021-01	3	17.35	0.81	13.95	0.88	30.33	R	26.33	0.48	
	FRM	89-021-01	4	6.35	0.98	5.15	0.99	12.23	0.92	10.03	0.94	
	FRM	89-021-01	5	8.13	0.96	6.28	0.98	15.13	0.87	12.28	0.92	
	FRM	89-021-01	6	4.65	0.99	2.85	0.99	11.55	0.93	8.75	0.95	
	FRM	89-021-01	7	2.75	0.99	2.75	0.99	5.98	0.99	5.35	0.99	
	FRM	89-021-01	8	0.08	1.00	0.00	1.00	3.66	0.99	2.58	0.99	
	FRM	89-021-01	9	0.00	1.00	0.00	1.00	0.20	1.00	0.20	1.00	
89-022	FRM	89-022-01	1	41.40	R	31.40	R	120.20	R	87.80	R	Central
	FRM	89-022-01	2	0.00	1.00	0.00	1.00	4.87	0.99	4.87	0.99	
89-023	HL-4	89-023-20	1	4.15	0.99	3.25	0.99	12.55	0.92	10.00	0.94	Northern
	HL-4	89-023-20	2	1.05	1.00	0.60	1.00	7.20	0.97	5.75	0.98	
89-023	HL-4	89-023-30	1	0.00	1.00	0.00	1.00	4.60	0.99	4.60	0.99	Northern
	HL-4	89-023-30	2	0.00	1.00	0.00	1.00	6.67	0.98	6.67	0.97	
89-025	HL-4	89-025-01	1	1.48	1.00	1.48	1.00	9.98	0.95	9.98	0.94	Central
89-026	HL-4	89-026-10	1	21.00	0.71	17.80	0.80	36.51	R	31.31	R	Eastern

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	HL-4	89-028-10	2	0.50	1.00	0.50	1.00	9.25	0.95	9.10	0.95	
	HL-4	89-028-10	3	0.00	1.00	0.00	1.00	1.95	1.00	1.80	1.00	
	HL-4	89-028-10	4	0.55	1.00	0.55	1.00	4.66	0.99	3.68	0.99	
	HL-4	89-028-10	5	5.23	0.99	4.15	0.99	22.46	0.68	19.26	0.77	
89-030	HL-3 MOD	89-030-20	1	9.30	0.95	6.70	0.97	10.70	0.94	7.10	0.97	Eastern
89-031	HL-3 MOD	89-031-10	1	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	Eastern
	HL-3 MOD	89-031-10	2	2.00	1.00	2.00	1.00	4.00	0.99	4.00	0.99	
	HL-3 MOD	89-031-10	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
89-031	HL-4HDB	89-031-20	1	0.00	1.00	0.00	1.00	3.63	0.99	3.63	0.99	Eastern
	HL-4HDB	89-031-20	2	3.20	0.99	3.20	0.99	11.20	0.93	11.20	0.93	
	HL-4HDB	89-031-20	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4HDB	89-031-20	4	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
89-032	HL-4	89-032-30	1	19.60	0.76	15.35	0.86	47.05	R	37.80	R	Eastern
	HL-4	89-032-30	2	0.00	1.00	1.60	1.00	1.08	1.00	0.73	1.00	
	HL-4	89-032-30	3	6.26	0.98	4.33	0.99	15.11	0.87	11.93	0.92	
	HL-4	89-032-30	4	8.13	0.96	6.40	0.98	21.47	0.71	16.74	0.77	
89-032	HL-4 HD	89-032-40	1	28.40	0.31	21.60	0.69	51.55	R	40.75	R	Eastern
89-032	OFC	89-032-50	1	9.83	0.94	7.38	0.97	15.43	0.87	11.88	0.92	Eastern
	OFC	89-032-50	2	3.16	0.99	2.65	0.99	7.18	0.97	5.65	0.98	
89-037	HL-4	89-037-10	1	16.50	0.84	14.35	0.88	50.60	R	46.25	R	Eastern
	HL-4	89-037-10	2	9.00	0.95	8.00	0.96	17.10	0.82	15.10	0.87	
	HL-4	89-037-10	3	7.80	0.96	5.90	0.98	17.25	0.82	14.35	0.88	
	HL-4	89-037-10	4	10.95	0.93	8.70	0.95	31.35	R	28.10	0.36	
89-037	HL-4	89-037-11	1	55.50	R	47.30	R	95.00	R	74.55	R	Eastern
89-037	HL-4	89-037-20	1	1.58	1.00	1.58	1.00	10.68	0.94	8.08	0.96	Eastern
	HL-4	89-037-20	2	7.80	0.96	6.40	0.98	34.68	R	25.88	0.50	
	HL-4	89-037-20	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-037-20	4	NOT	DETERMINED							
	HL-4	89-037-20	5	14.80	0.87	13.40	0.90	42.80	R	37.40	R	
	HL-4	89-037-20	6	0.40	1.00	0.40	1.00	19.95	0.77	18.15	0.80	
	HL-4	89-037-20	7	0.28	1.00	0.28	1.00	5.51	0.99	5.51	0.98	
	HL-4	89-037-20	8	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	
89-037	HL-3	89-037-30	1	0.00	1.00	0.00	1.00	0.40	1.00	0.40	1.00	Eastern
	HL-3	89-037-30	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	4	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	
	HL-3	89-037-30	5	2.40	1.00	2.40	1.00	8.98	0.96	8.98	0.95	

Table 4 Simulation Data from '87, '88 and '89 Contracts

... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO	CRITERIA	REDUCED	SIEVES	ASTM	CRITERIA	REDUCED	SIEVES	Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	HL-3	89-037-30	6	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	8	0.00	1.00	0.00	1.00	5.80	0.99	5.80	0.98	
	HL-3	89-037-30	9	0.00	1.00	0.00	1.00	1.20	1.00	0.00	1.00	
	HL-3	89-037-30	10	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	11	6.12	0.98	6.12	0.98	8.40	0.96	8.40	0.96	
	HL-3	89-037-30	12	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-3	89-037-30	13	0.00	1.00	0.00	1.00	1.20	1.00	1.20	1.00	
	HL-3	89-037-30	14	0.00	1.00	0.00	1.00	2.68	1.00	2.68	0.99	
89-039	HL-4	89-039-20	1	66.10	R	55.90	R	88.30	R	74.10	R	Eastern
	HL-4	89-039-20	2	6.90	0.97	6.90	0.97	10.40	0.94	10.40	0.94	
	HL-4	89-039-20	3	3.25	0.99	3.25	0.99	6.49	0.98	6.41	0.98	
89-040	RHM	89-040-02	1	1.20	1.00	1.20	1.00	12.70	0.92	12.70	0.90	Southwestern
	RHM	89-040-02	2	0.63	1.00	0.63	1.00	4.15	0.99	4.15	0.99	
89-043	HL-3	89-043-10	1	0.00	1.00	0.00	1.00	1.35	1.00	1.35	1.00	Eastern
	HL-3	89-043-10	2	3.10	0.99	3.10	0.99	4.20	0.99	4.20	0.99	
	HL-3	89-043-10	3	9.00	0.95	8.00	0.96	5.67	0.99	5.67	0.98	
89-044	RHM	89-044-02	1	8.60	0.95	8.60	0.95	25.60	0.56	23.40	0.62	Central
	RHM	89-044-02	2	0.00	1.00	0.00	1.00	0.25	1.00	0.25	1.00	
	RHM	89-044-02	3	5.00	0.99	5.00	0.99	11.18	0.93	11.18	0.93	
	RHM	89-044-02	4	0.00	1.00	0.00	1.00	1.20	1.00	1.20	1.00	
	RHM	89-044-02	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	RHM	89-044-02	6	0.00	1.00	0.00	1.00	0.80	1.00	0.80	1.00	
	RHM	89-044-02	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	RHM	89-044-02	8	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	RHM	89-044-02	9	0.00	1.00	0.00	1.00	0.65	1.00	0.65	1.00	
	RHM	89-044-02	10	0.00	1.00	0.00	1.00	0.50	1.00	0.50	1.00	
	RHM	89-044-02	11	2.55	0.99	0.55	1.00	23.21	0.64	16.86	0.82	
	RHM	89-044-02	12	0.10	1.00	0.10	1.00	1.10	1.00	1.10	1.00	
	RHM	89-044-02	13	0.00	1.00	0.00	1.00	5.20	0.99	3.80	0.99	
	RHM	89-044-02	14	6.60	0.97	6.60	0.97	14.55	0.88	14.55	0.88	
89-044	HL-8	89-044-03	1	10.40	0.94	0.00	1.00	35.90	R	11.75	0.92	Central
89-046	RHM	89-046-01	1	0.00	1.00	0.00	1.00	2.38	1.00	2.38	1.00	Central
	RHM	89-046-01	2	1.00	1.00	1.00	1.00	3.00	0.99	3.00	0.99	
89-056	RHM	89-056-03	1	9.95	0.94	8.18	0.96	21.81	0.71	19.03	0.77	Central
	RHM	89-056-03	2	10.62	0.93	9.27	0.95	39.22	R	33.67	R	
	RHM	89-056-03	3	1.53	1.00	1.53	1.00	6.28	0.98	5.93	0.98	
	RHM	89-056-03	4	8.18	0.96	6.95	0.97	26.89	0.50	24.36	0.58	
	RHM	89-056-03	5	0.40	1.00	0.40	1.00	7.43	0.97	7.43	0.97	
	RHM	89-056-03	6	0.00	1.00	0.00	1.00	2.85	0.99	2.85	0.99	

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO CRITERIA		REDUCED SIEVES		ASTM CRITERIA		REDUCED SIEVES		Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	RHM	89-056-03	7	1.30	1.00	1.30	1.00	6.60	0.98	6.60	0.97	
	RHM	89-056-03	8	18.60	0.79	15.03	0.87	51.61	R	42.03	R	
	RHM	89-056-03	9	20.46	0.73	15.28	0.87	51.51	R	41.28	R	
	RHM	89-056-03	10	2.76	0.99	2.76	0.99	6.88	0.98	6.88	0.97	
	RHM	89-056-03	11	0.50	1.00	0.50	1.00	5.10	0.99	5.10	0.99	
	RHM	89-056-03	12	0.00	1.00	0.00	1.00	1.15	1.00	1.15	1.00	
	RHM	89-056-03	13	0.35	1.00	0.35	1.00	5.25	0.99	5.25	0.99	
	RHM	89-056-03	14	4.75	0.99	4.75	0.99	14.33	0.88	13.38	0.90	
	RHM	89-056-03	15	3.70	0.99	3.70	0.99	10.95	0.94	10.20	0.94	
89-070	HL-4	89-070-01	1	1.93	1.00	0.33	1.00	7.14	0.97	3.53	0.99	Central
	HL-4	89-070-01	2	2.76	0.99	0.45	1.00	9.01	0.95	4.68	0.99	
	HL-4	89-070-01	3	0.65	1.00	0.20	1.00	6.66	0.98	4.63	0.99	
	HL-4	89-070-01	4	8.80	0.95	7.40	0.97	23.57	0.64	17.44	0.81	
	HL-4	89-070-01	5	6.05	0.98	3.95	0.99	10.80	0.94	7.70	0.96	
	HL-4	89-070-01	6	6.53	0.98	4.45	0.99	9.03	0.95	5.95	0.98	
89-075	HL-4	89-075-10	1	0.00	1.00	0.00	1.00	8.20	0.96	7.80	0.96	Eastern
	HL-4	89-075-10	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-075-10	3	0.00	1.00	0.00	1.00	0.08	1.00	0.08	1.00	
	HL-4	89-075-10	4	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-075-10	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-075-10	6	2.00	1.00	2.00	1.00	7.40	0.97	7.40	0.97	
	HL-4	89-075-10	7	0.00	1.00	0.00	1.00	9.03	0.96	7.50	0.97	
	HL-4	89-075-10	8	0.00	1.00	0.00	1.00	0.73	1.00	0.50	1.00	
	HL-4	89-075-10	9	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-075-10	10	0.00	1.00	0.00	1.00	1.92	1.00	1.53	1.00	
89-076	HL-4	89-076-20	1	3.20	0.99	3.20	0.99	6.21	0.98	6.21	0.98	Eastern
	HL-4	89-076-20	2	12.19	0.92	12.19	0.92	24.19	0.60	24.19	0.59	
	HL-4	89-076-20	3	0.85	1.00	0.85	1.00	3.10	0.99	3.10	0.99	
	HL-4	89-076-20	4	11.95	0.92	11.95	0.92	16.95	0.85	16.95	0.82	
	HL-4	89-076-20	5	3.55	0.99	3.55	0.99	6.55	0.98	6.55	0.98	
	HL-4	89-076-20	6	12.64	0.91	12.64	0.91	19.64	0.77	19.64	0.75	
	HL-4	89-076-20	7	4.55	0.99	4.55	0.99	7.55	0.97	7.55	0.97	
	HL-4	89-076-20	8	6.65	0.97	6.65	0.97	13.73	0.90	13.65	0.89	
89-078	HL-4	89-078-10	1	8.20	0.96	8.20	0.96	21.98	0.71	18.78	0.77	Eastern
	HL-4	89-078-10	2	2.80	0.99	2.80	0.99	7.98	0.97	7.98	0.96	
	HL-4	89-078-10	3	10.40	0.94	10.40	0.94	16.50	0.87	16.50	0.84	
	HL-4	89-078-10	4	13.20	0.90	9.20	0.95	35.35	R	27.35	0.42	
89-079	HL-4	89-079-5228	1	1.60	1.00	1.60	1.00	13.60	0.90	9.60	0.94	Eastern
	HL-4	89-079-5228	2	1.70	1.00	1.70	1.00	8.85	0.96	8.85	0.95	
	HL-4	89-079-5228	3	0.00	1.00	0.00	1.00	3.20	0.99	3.20	0.99	
	HL-4	89-079-5228	4	0.53	1.00	0.53	1.00	5.63	0.99	5.63	0.98	
	HL-4	89-079-5228	5	2.00	1.00	2.00	1.00	7.83	0.97	7.83	0.96	

Table 4 Simulation Data from '87, '88 and '89 Contracts

... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO CRITERIA		REDUCED SIEVES		ASTM CRITERIA		REDUCED SIEVES		Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	HL-4	89-079-5228	6	2.05	1.00	2.05	1.00	4.55	0.99	4.55	0.99	
89-069	DFC	89-069-03	1	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	Central
89-069	HL-8	89-069-03	1	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	Central
89-201	R&M	89-201-10	1	0.15	1.00	0.15	1.00	2.15	1.00	2.15	1.00	Northern
	R&M	89-201-10	2	1.85	1.00	1.85	1.00	10.53	0.94	9.65	0.94	
	R&M	89-201-10	3	1.05	1.00	1.05	1.00	9.01	0.95	8.23	0.96	
	R&M	89-201-10	4	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	6	0.00	1.00	0.00	1.00	1.45	1.00	1.45	1.00	
	R&M	89-201-10	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	8	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	9	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	10	4.00	0.99	4.00	0.99	27.80	0.44	20.40	0.73	
	R&M	89-201-10	11	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	12	0.00	1.00	0.00	1.00	0.25	1.00	0.25	1.00	
	R&M	89-201-10	13	0.00	1.00	0.00	1.00	1.30	1.00	1.30	1.00	
	R&M	89-201-10	14	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	15	0.00	1.00	0.00	1.00	0.20	1.00	0.20	1.00	
	R&M	89-201-10	16	10.63	0.93	9.63	0.94	22.83	0.68	20.63	0.73	
	R&M	89-201-10	17	2.45	1.00	2.10	1.00	13.40	0.90	12.05	0.92	
	R&M	89-201-10	18	4.13	0.99	3.63	0.99	16.13	0.85	14.63	0.87	
	R&M	89-201-10	19	0.95	1.00	0.95	1.00	9.46	0.95	8.51	0.96	
	R&M	89-201-10	20	0.00	1.00	0.00	1.00	0.15	1.00	0.15	1.00	
	R&M	89-201-10	21	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	22	0.00	1.00	0.00	1.00	2.11	1.00	1.93	1.00	
	R&M	89-201-10	23	0.00	1.00	0.00	1.00	0.60	1.00	0.60	1.00	
	R&M	89-201-10	24	0.00	1.00	0.00	1.00	0.40	1.00	0.40	1.00	
	R&M	89-201-10	25	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	26	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	27	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	R&M	89-201-10	28	0.85	1.00	0.85	1.00	8.70	0.96	8.00	0.96	
	R&M	89-201-10	29	0.00	1.00	0.00	1.00	1.40	1.00	1.40	1.00	
	R&M	89-201-10	30	0.00	1.00	0.00	1.00	0.05	1.00	0.05	1.00	
89-202	HL-4	89-202-10	1	0.00	1.00	0.00	1.00	0.20	1.00	0.20	1.00	Northern
	HL-4	89-202-10	2	10.38	0.94	10.38	0.94	35.81	R	34.98	R	
89-202	HL-4	89-202-11	1	16.40	0.84	16.40	0.84	40.95	R	37.00	R	Northern
	HL-4	89-202-11	2	1.60	1.00	1.60	1.00	12.20	0.92	12.20	0.92	
	HL-4	89-202-11	3	0.10	1.00	0.10	1.00	0.70	1.00	0.70	1.00	
	HL-4	89-202-11	4	9.95	0.94	4.55	0.99	27.10	0.44	17.70	0.81	
89-204	R&M	89-204-10	1	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	Northern
	R&M	89-204-10	2	0.00	1.00	0.00	1.00	0.00	1.00	0.40	1.00	

Table 4 Simulation Data from '87, '88 and '89 Contracts ... continued

CONTRACT #	MIX TYPE	MIXDESIGN#	LOT #	MTO CRITERIA		REDUCED SIEVES		ASTM CRITERIA		REDUCED SIEVES		Region
				ADJ.POINTS	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	TOT.ADJ.PTS.	PAY FACTOR	
	P-M	89-204-10	3	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	4	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	6	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	8	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	9	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	10	0.20	1.00	0.20	1.00	10.78	0.94	10.78	0.93	
	P-M	89-204-10	11	1.80	1.00	1.60	1.00	10.80	0.94	10.80	0.93	
	P-M	89-204-10	12	4.00	0.99	4.00	0.99	11.00	0.93	11.00	0.93	
	P-M	89-204-10	13	1.00	1.00	1.00	1.00	10.26	0.94	9.78	0.94	
	P-M	89-204-10	14	0.00	1.00	0.00	1.00	7.85	0.97	7.25	0.97	
	P-M	89-204-10	15	4.20	0.99	4.20	0.99	27.60	0.44	21.60	0.69	
	P-M	89-204-10	16	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	17	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	18	0.80	1.00	0.80	1.00	7.80	0.97	7.80	0.96	
	P-M	89-204-10	19	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	P-M	89-204-10	20	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
89-230	HL-4	89-230-10	1	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	Northern
	HL-4	89-230-10	2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-230-10	3	0.00	1.00	0.00	1.00	1.26	1.00	1.26	1.00	
	HL-4	89-230-10	4	0.00	1.00	0.00	1.00	3.80	0.99	3.80	0.99	
	HL-4	89-230-10	5	0.00	1.00	0.00	1.00	2.13	1.00	2.13	1.00	
	HL-4	89-230-10	6	0.00	1.00	0.00	1.00	2.80	1.00	2.80	0.99	
	HL-4	89-230-10	7	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
89-231	HL-4	89-231-20	1	0.53	1.00	0.00	1.00	2.08	1.00	0.55	1.00	Northern
	HL-4	89-231-20	2	8.08	0.96	7.10	0.97	19.48	0.77	15.10	0.87	
	HL-4	89-231-20	3	4.00	0.99	2.00	1.00	22.23	0.68	11.43	0.93	
	HL-4	89-231-20	4	0.05	1.00	0.00	1.00	1.55	1.00	0.50	1.00	
	HL-4	89-231-20	5	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	
	HL-4	89-231-20	6	0.00	1.00	0.00	1.00	1.08	1.00	0.25	1.00	
	HL-4	89-231-20	7	0.20	1.00	0.00	1.00	10.06	0.94	4.78	0.99	
	HL-4	89-231-20	8	0.15	1.00	0.00	1.00	2.88	1.00	0.00	1.00	
	HL-4	89-231-20	9	0.00	1.00	0.00	1.00	1.30	1.00	0.45	1.00	
	HL-4	89-231-20	10	6.60	0.97	6.60	0.97	14.30	0.88	14.10	0.88	
	HL-4	89-231-20	11	0.00	1.00	0.00	1.00	1.78	1.00	1.13	1.00	
89-304	HL-4	89-304-	1	160.23	R	129.93	R	220.34	R	160.83	R	Central
	HL-4	89-304-	2	0.70	1.00	0.00	1.00	3.26	1.00	1.58	1.00	
		AVERAGES:		5.251	0.977	4.081	0.980	13.998	0.930	11.266	0.930	
		# REJECTABLE LOTS:			12		9		46		36	
		# LOTS PAID @ FULL PRICE:			254		262		134		135	

Table 4 Simulation Data from '87, '88 and '89 Contracts

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR	JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR
87-060-07	1	15.200	0.924		4	3.375	0.983
87-075-02	1	0.000	1.000	88-014-60	1	3.840	0.981
					2	0.000	1.000
87-075-03	1	5.775	0.971		3	0.000	1.000
87-076-04	1	11.200	0.944	88-021-02	1	1.300	0.994
	2	0.000	1.000		2	3.250	0.984
	3	0.000	1.000		3	0.000	1.000
					4	0.000	1.000
87-076-07	1	0.000	1.000		5	0.000	1.000
	2	0.000	1.000		6	0.000	1.000
	3	0.000	1.000		7	0.000	1.000
					8	0.000	1.000
87-076-01	1	0.000	1.000		9	0.000	1.000
	2	1.300	0.994		10	0.000	1.000
	3	7.900	0.961		11	3.200	0.984
	4	0.775	0.996		12	0.000	1.000
	5	16.400	0.918				
	6	1.850	0.991	88-025-10	1	0.000	1.000
	7	34.675	R		2	0.000	1.000
	8	1.850	0.991				
	9	0.000	1.000	88-026-20	1	14.400	0.926
	10	1.300	0.994		2	9.800	0.951
					3	12.150	0.939
87-092-01	1	0.300	0.999		4	12.675	0.937
	2	0.275	0.999		5	13.900	0.931
	3	1.200	0.994		6	21.750	0.848
	4	0.650	0.997		7	17.350	0.913
					8	18.800	0.906
87-093-14	1	8.500	0.958				
	2	11.715	0.941	88-026-40	1	4.250	0.979
	3	0.400	0.998		2	6.740	0.966
					3	17.700	0.912
87-229-20	1	0.000	1.000				
	2	8.625	0.957	88-048-01	1	0.200	0.999
					2	0.675	0.997
88-014-10	1	0.000	1.000		3	4.590	0.977
					4	10.800	0.946
88-014-20	1	0.225	0.999				
	2	3.600	0.982	88-067-04	1	1.950	0.990
	3	0.000	1.000		2	5.275	0.974
					3	4.925	0.975
88-014-30	1	13.475	0.933		4	1.650	0.992
	2	1.625	0.992		5	3.675	0.982
	3	2.250	0.989		6	0.825	0.996

Table 5 Effect of using Straight Line ...continued
Pay Factor determination.

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR	JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR
	7	2.225	0.989		9	0.350	0.998
	8	1.925	0.990		10	0.000	1.000
					11	0.000	1.000
88-067-07	1	6.125	0.969				
	2	0.075	1.000	88-079-03	1	0.000	1.000
	3	1.200	0.994		2	0.000	1.000
	4	0.000	1.000				
	5	2.850	0.986	88-079-02	1	0.150	0.999
					2	0.000	1.000
88-067-01	1	7.575	0.962		3	0.000	1.000
	2	57.250	R		4	0.000	1.000
	3	67.100	R		5	7.400	0.963
	4	25.475	0.736		6	0.000	1.000
	5	1.750	0.991		7	3.750	0.981
	6	70.500	R		8	0.700	0.997
	7	131.525	R				
	8	31.575	R	88-086-10	1	1.400	0.993
					2	0.250	0.999
88-067-03	1	6.350	0.968		3	1.875	0.991
	2	6.800	0.966		4	6.950	0.965
	3	0.000	1.000		5	1.450	0.993
	4	4.450	0.978				
	5	2.800	0.986	88-203-10	1	21.640	0.851
	6	5.650	0.972		2	0.000	1.000
	7	33.900	R		3	0.000	1.000
	8	6.100	0.970		4	0.000	1.000
	9	19.650	0.902		5	0.000	1.000
					6	0.000	1.000
88-067-05	1	1.150	0.994		7	0.000	1.000
88-071-01	1	0.000	1.000	88-203-20	1	1.500	0.993
	2	0.000	1.000		2	0.000	1.000
	3	0.000	1.000		3	0.400	0.998
	4	0.000	1.000		4	16.800	0.916
	5	0.000	1.000		5	0.000	1.000
	6	0.500	0.998		6	0.000	1.000
	7	1.375	0.993		7	0.500	0.998
					8	0.000	1.000
88-077-03	1	45.400	R		9	0.000	1.000
	2	0.000	1.000		10	0.350	0.998
	3	8.400	0.958		11	1.200	0.994
	4	0.000	1.000		12	0.600	0.997
	5	0.000	1.000		13	0.500	0.998
	6	0.000	1.000				
	7	0.000	1.000	88-213-10	1	0.000	1.000
	8	0.600	0.997		2	0.000	1.000

Table 5 Effect of using Straight Line Pay Factor determination. ...continued

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR	JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR
			1.000		2	0.000	1.000
88-213-11	1	15.725	0.921				
				89-025-01	1	1.475	0.993
88-226-20	1	6.750	0.966				
	2	8.375	0.958	89-028-10	1	21.000	0.870
	3	0.000	1.000		2	0.500	0.998
	4	0.000	1.000		3	0.000	1.000
					4	0.550	0.997
89-007-10	1	0.825	0.996		5	5.225	0.974
89-012-10	1	0.200	0.999	89-030-20	1	9.300	0.954
89-013-11	1	1.700	0.992	89-031-10	1	0.000	1.000
	2	2.000	0.990		2	2.000	0.990
	3	9.800	0.951		3	0.000	1.000
	4	9.580	0.952				
	5	9.330	0.953	89-31-20	1	0.000	1.000
	6	10.530	0.947		2	3.200	0.984
					3	0.000	1.000
89-017-10	1	0.000	1.000		4	0.000	1.000
89-019-10	1	0.200	0.999	89-032-30	1	19.600	0.902
	2	0.000	1.000		2	1.600	0.992
	3	0.000	1.000		3	6.275	0.969
	4	0.000	1.000		4	8.125	0.959
	5	0.000	1.000				
	6	0.000	1.000	89-032-40	1	28.400	0.648
	7	0.000	1.000				
				89-032-50	1	9.825	0.951
89-021-01	1	6.725	0.966		2	3.175	0.984
	2	15.925	0.920				
	3	17.350	0.913	89-037-10	1	16.500	0.918
	4	6.350	0.968		2	9.000	0.955
	5	8.125	0.959		3	7.800	0.961
	6	4.650	0.977		4	10.950	0.945
	7	2.750	0.986				
	8	0.075	1.000	89-037-11	1	55.500	R
	9	0.000	1.000				
				89-037-20	1	1.575	0.992
89-022-01	1	41.400	R		2	7.800	0.961
	2	0.000	1.000		3	0.000	1.000
					4	0.000	1.000
89-023-20	1	4.150	0.979		5	14.800	0.926
	2	1.050	0.995		6	0.400	0.998
					7	0.275	0.999
89-023-30	1	0.000	1.000		8	0.000	1.000

Table 5 Effect of using Straight Line Pay Factor determination. ...continued

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR	JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR
89-037-30	1	0.000	1.000	89-056-03	1	9.950	0.950
	2	0.000	1.000		2	10.615	0.947
	3	0.000	1.000		3	1.525	0.992
	4	0.000	1.000		4	8.175	0.959
	5	2.400	0.988		5	0.400	0.998
	6	0.000	1.000		6	0.000	1.000
	7	0.000	1.000		7	1.300	0.994
	8	0.000	1.000		8	18.600	0.907
	9	0.000	1.000		9	20.475	0.886
	10	0.000	1.000		10	2.775	0.986
	11	6.120	0.969		11	0.500	0.998
	12	0.000	1.000		12	0.000	1.000
	13	0.000	1.000		13	0.350	0.998
	14	0.000	1.000		14	4.750	0.976
					15	3.700	0.982
89-039-20	1	66.100	R				
	2	6.900	0.966	89-070-01	1	1.925	0.990
	3	3.250	0.984		2	2.775	0.986
					3	0.650	0.997
89-040-02	1	1.200	0.994		4	8.800	0.956
	2	0.625	0.997		5	6.050	0.970
					6	6.525	0.967
89-043-10	1	0.000	1.000				
	2	3.100	0.985	89-075-10	1	0.000	1.000
	3	9.000	0.955		2	0.000	1.000
					3	0.000	1.000
89-044-02	1	8.600	0.957		4	0.000	1.000
	2	0.000	1.000		5	0.000	1.000
	3	5.000	0.975		6	2.000	0.990
	4	0.000	1.000		7	0.000	1.000
	5	0.000	1.000		8	0.000	1.000
	6	0.000	1.000		9	0.000	1.000
	7	0.000	1.000		10	0.000	1.000
	8	0.000	1.000				
	9	0.000	1.000	89-076-20	1	3.200	0.984
	10	0.000	1.000		2	12.190	0.939
	11	2.550	0.987		3	0.850	0.996
	12	0.100	1.000		4	11.950	0.940
	13	0.000	1.000		5	3.550	0.982
	14	6.600	0.967		6	12.640	0.937
					7	4.550	0.977
89-044-03	1	10.400	0.948		8	6.650	0.967
89-046-01	1	0.000	1.000	89-078-10	1	8.200	0.959
	2	1.000	0.995		2	2.800	0.986
					3	10.400	0.948

Table 5 Effect of using Straight Line Pay Factor determination. ...continued

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR	JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR
	4	13.200	0.934	89-202-11	1	16.400	0.918
					2	1.600	0.992
89-079-5228	1	1.600	0.992		3	0.100	1.000
	2	1.700	0.992		4	9.950	0.950
	3	0.000	1.000				
	4	0.525	0.997	89-204-10	1	0.000	1.000
	5	2.000	0.990		2	0.000	1.000
	6	2.050	0.990		3	0.000	1.000
					4	0.000	1.000
89-089-03	1	0.000	1.000		5	0.000	1.000
					6	0.000	1.000
89-089-03	1	0.000	1.000		7	0.000	1.000
					8	0.000	1.000
89-201-10	1	0.150	0.999		9	0.000	1.000
	2	1.850	0.991		10	0.200	0.999
	3	1.050	0.995		11	1.600	0.992
	4	0.000	1.000		12	4.000	0.980
	5	0.000	1.000		13	1.000	0.995
	6	0.000	1.000		14	0.000	1.000
	7	0.000	1.000		15	4.200	0.979
	8	0.000	1.000		16	0.000	1.000
	9	0.000	1.000		17	0.000	1.000
	10	4.000	0.980		18	0.800	0.996
	11	0.000	1.000		19	0.000	1.000
	12	0.000	1.000		20	0.000	1.000
	13	0.000	1.000				
	14	0.000	1.000	89-230-10	1	0.000	1.000
	15	0.000	1.000		2	0.000	1.000
	16	10.825	0.946		3	0.000	1.000
	17	2.450	0.988		4	0.000	1.000
	18	4.125	0.979		5	0.000	1.000
	19	0.950	0.995		6	0.000	1.000
	20	0.000	1.000		7	0.000	1.000
	21	0.000	1.000				
	22	0.000	1.000	89-231-20	1	0.525	0.997
	23	0.000	1.000		2	8.075	0.960
	24	0.000	1.000		3	4.000	0.980
	25	0.000	1.000		4	0.050	1.000
	26	0.000	1.000		5	0.000	1.000
	27	0.000	1.000		6	0.000	1.000
	28	0.850	0.996		7	0.200	0.999
	29	0.000	1.000		8	0.150	0.999
	30	0.000	1.000		9	0.000	1.000
					10	6.600	0.967
89-202-10	1	0.000	1.000		11	0.000	1.000
	2	10.375	0.948				

Table 5 Effect of using Straight Line ...continued
Pay Factor determination.

JMF#	LOT#	TOT.ADJ.PTS.	PAY FACTOR					
89-304-	1	180.225	R					
	2	0.700	0.997					
AVERAGE		5.170	0.983					

Table 5 Effect of using Straight Line Pay Factor determination.

CONTRACT	MIXDESIGN#	LOT	HL-8	TOLERANCES	STANDARD	TOLERANCES
			TOT. ADJ. PTS	PAY FACTOR	TOT. ADJ. PTS	PAY FACTOR
87-76	87-076-01	1	0.00	1.00	2.35	1.00
		2	1.30	1.00	11.25	0.93
		3	7.90	0.96	15.55	0.86
		4	0.78	1.00	2.93	0.99
		5	16.40	0.84	31.60	R
		6	1.85	1.00	4.88	0.99
		7	34.68	R	63.73	R
		8	1.85	1.00	4.25	0.99
		9	0.00	1.00	1.13	1.00
		10	1.30	1.00	3.15	0.99
88-48	88-048-01	1	0.20	1.00	11.13	0.93
		2	0.68	1.00	3.16	0.99
		3	4.59	0.99	6.35	0.98
		4	10.80	0.93	26.10	0.50
88-67	88-067-01	1	7.58	0.96	30.99	R
		2	57.25	R	89.51	R
		3	67.10	R	99.82	R
		4	25.48	0.53	56.07	R
		5	1.75	1.00	9.93	0.94
		6	70.50	R	111.33	R
		7	131.53	R	171.15	R
		8	31.58	R	57.48	R
	88-067-03	1	6.35	0.98	27.35	0.41
		2	6.80	0.97	7.90	0.96
		3	0.00	1.00	0.15	1.00
		4	4.45	0.99	11.90	0.92
		5	2.80	0.99	24.39	0.58
		6	5.65	0.98	9.25	0.95
		7	33.90	R	70.51	R
		8	6.10	0.98	7.93	0.96
		9	19.65	0.76	40.30	R
	88-067-05	1	1.15	1.00	12.33	0.92
88-79	88-079-02	1	0.15	1.00	1.18	1.00
		2	0.00	1.00	7.20	0.97
		3	0.00	1.00	0.00	1.00
		4	0.00	1.00	0.00	1.00
		5	7.40	0.97	25.43	0.53
		6	0.00	1.00	7.20	0.97
		7	3.75	0.99	13.75	0.89
		8	0.70	1.00	15.18	0.87
89-44	89-044-03	1	10.40	0.94	20.20	0.76
89-89	89-089-03	1	0.00	1.00	0.00	1.00
		AVERAGE=	13.913	0.965	26.571	0.896
	NO. OF REJECTABLE LOTS=			7		11

Table 6 Effect of Changing HL-8 Tolerance Limits

APPENDIX A

Tables from February 1989 Draft
"Acceptance and Price Adjustment Based on
Asphalt Cement Content and Aggregate Gradation"

TABLE 1

MAXIMUM TOLERANCE REQUIREMENTS FROM JOB-MIX FORMULA
SURFACE, BINDER AND LEVELLING COURSE MIXES EXCEPT HL8 MIXES

Number of sublots	4	5	6	7	8	9	10	11	12	13	14
Tolerances (Percentage Points)											
Asphalt Cement Content / Sieve	±0.30	±0.27	±0.25	±0.23	±0.21	±0.20	±0.19	±0.18	±0.17	±0.17	±0.16
19.0, 16.0, 13.2, 9.5, 4.75 mm	±5.0	±4.5	±4.1	±3.8	±3.5	±3.3	±3.2	±3.0	±2.9	±2.8	±2.7
2.36 mm	±4.5	±4.0	±3.7	±3.4	±3.2	±3.0	±2.8	±2.7	±2.6	±2.5	±2.4
1.18 mm	±4.0	±3.6	±3.3	±3.0	±2.8	±2.7	±2.5	±2.4	±2.3	±2.2	±2.1
600 µm	±3.5	±3.1	±2.8	±2.6	±2.5	±2.3	±2.2	±2.1	±2.0	±1.9	±1.9
300 µm	±3.0	±2.7	±2.5	±2.3	±2.1	±2.0	±1.9	±1.8	±1.7	±1.7	±1.6
150 µm	±2.5	±2.2	±2.0	±1.9	±1.8	±1.7	±1.6	±1.5	±1.4	±1.4	±1.3
75 µm	±2.0	±1.8	±1.6	±1.5	±1.4	±1.3	±1.3	±1.2	±1.2	±1.1	±1.1

TABLE 2

MAXIMUM TOLERANCE REQUIREMENTS FROM JOB-MIX FORMULA
HL8 MIXES

Number of sublots	4	5	6	7	8	9	10	11	12	13	14
Tolerances (Percentage Points)											
Sieve \ Asphalt Cement Content	±0.30	±0.27	±0.25	±0.23	±0.21	±0.20	±0.19	±0.18	±0.17	±0.17	±0.16
26.5, 19.0, 16.0, 13.2, 9.5, 4.75 mm	±7.0	±6.2	±5.7	±5.3	±4.9	±4.7	±4.4	±4.2	±4.0	±3.9	±3.7
2.36 mm	±6.0	±5.4	±4.9	±4.5	±4.2	±4.0	±3.8	±3.6	±3.5	±3.3	±3.2
1.18 mm	±5.0	±4.5	±4.1	±3.8	±3.5	±3.3	±3.2	±3.0	±2.9	±2.8	±2.7
600 µm	±4.5	±4.0	±3.7	±3.4	±3.2	±3.0	±2.8	±2.7	±2.6	±2.5	±2.4
300 µm	±4.0	±3.6	±3.3	±3.0	±2.8	±2.7	±2.5	±2.4	±2.3	±2.2	±2.1
150 µm	±3.0	±2.7	±2.5	±2.3	±2.1	±2.0	±1.9	±1.8	±1.7	±1.7	±1.6
75 µm	±2.0	±1.8	±1.6	±1.5	±1.4	±1.3	±1.3	±1.2	±1.2	±1.1	±1.1

TABLE 3

MAXIMUM ALLOWABLE LOT RANGE FOR
SURFACE, BINDER AND LEVELLING COURSE MIXES EXCEPT HL8 MIXES

Characteristic / Allowable Lot Range	Asphalt Cement Content	Designated Sieve						
		mm			µm			
		19.0 to 4.75	2.36	1.18	600	300	150	75
Percentage Points	0.60	10.0	9.0	8.0	7.0	6.0	5.0	4.0

MAXIMUM ALLOWABLE LOT RANGE FOR HL8 MIXES

Characteristic / Allowable Lot Range	Asphalt Cement Content	Designated Sieve						
		mm			µm			
		26.5 to 4.75	2.36	1.18	600	300	150	75
Percentage Points	0.60	14.0	12.0	10.0	9.0	8.0	6.0	4.0

TABLE 4
ADJUSTMENT POINTS

Characteristic	Adjustment Points for each 0.01 % Deviation Beyond Requirements of Tables 1, 2 and 3	
	Mean	Range
Asphalt Cement Content	0.8	0.2

Sieve		Adjustment Points for each 0.1 % Deviation Beyond Requirements of Tables 1, 2 and 3	
		Mean	Range
26.5, 19.0, 16.0, 13.2, 9.5 mm		0.1	0.2
4.75 mm		0.5	0.2
2.36, 1.18 mm		0.1	0.2
600, 300, 150 µm		0.2	0.2
75 µm	≤ 1.0 % Deviation	1.0	0.2
	> 1.0 % Deviation	2.0	0.4

TABLE 5
ADJUSTMENT POINTS AND PAY FACTORS

Adj. Points	Pay Factor
0	1.00
1	1.00
2	1.00
3	0.99
4	0.99
5	0.99
6	0.98
7	0.97
8	0.96
9	0.95
10	0.94

Adj. Points	Pay Factor
11	0.93
12	0.92
13	0.90
14	0.88
15	0.87
16	0.85
17	0.82
18	0.80
19	0.77
20	0.75
21	0.71

Adj. Points	Pay Factor
22	0.68
23	0.64
24	0.60
25	0.55
26	0.50
27	0.44
28	0.36
29	0.26

WARRANT: With these tender items when the tender quantity for the item is 2000 t or greater.

On trial contracts which require the ERS for aggregate gradation and asphalt cement content to be used. The trial contracts will be picked by the Contract Management Office. THIS NSSP IS PART OF A PACKAGE AND IS NOT TO BE USED ON OTHER CONTRACTS.

APPENDIX B

Analysis by MTO Criteria

ANALYSIS BY MTO CRITERIA - ALL SIEVES

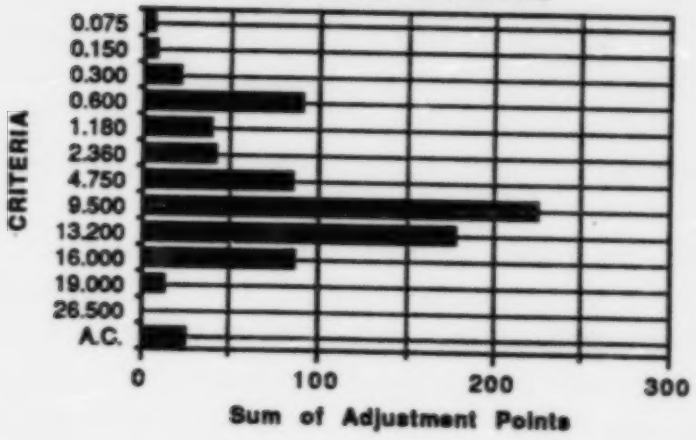
The MTO Criteria are detailed in the draft special provision Acceptance and Price Adjustment Based on Asphalt Cement Content and Aggregate Gradation dated February 1989 and this simulation included the assessment of price adjustments on all sieves. An assessment of this simulation is given below:

B.1 REJECTABLE LOTS

12 lots were determined as being rejectable representing 24,000 tonnes or 3.07% of the total. A further assessment of the occurrence of adjustment points reveals that 6 of these lots were all from the same contract (Contract 88-67) where an HL-8 Heavy Duty binder course had been laid. On this one contract, the majority of adjustment points were accrued on the coarse aggregate fraction of the grading, mainly where the range of values exceeded the permitted range. This indicates that some aspect of the operation on this contract was out of control.

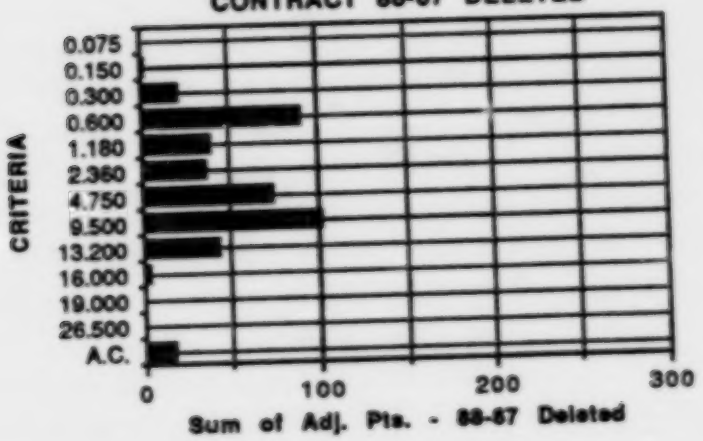
Fig. 1 indicates where the penalty points were accrued on these 12 rejectable lots. It should be remembered that the penalty for any deviation on the 4.75 mm sieve is 5 times the penalty for the same deviation on the other coarse aggregate sieves. Thus the majority of the penalties occurred on the coarse aggregate sieves notably the 9.5 mm and 13.2 mm. The 600 µm sieve also contributed significantly.

Fig. 1 MTO FULL CRITERIA REJECTABLE MATERIAL



When the data from contract 88-67 was omitted the number of rejectable lots was reduced to 6 representing 12,000 tonnes or 1.54% of the total. The distribution of penalty points is changed as seen in Fig. 2. The contribution from the fine aggregate portion is now more significant and closer to the contribution from the coarse aggregate fraction.

Fig. 2 MTO FULL CRITERIA
REJECTABLE MATERIAL
CONTRACT 88-67 DELETED

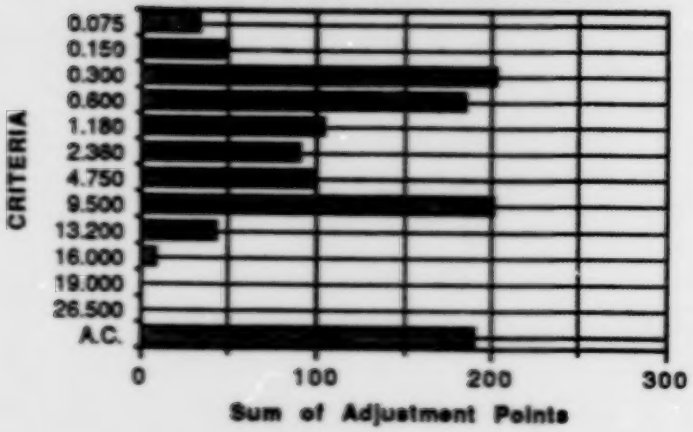


If the scheme had been applied to all hot mix placed in 1989 the projected total rejectable material would have been 46,357 tonnes. At a hot mix price of $40 per tonne this represents $1,854,280. However, by excluding the data from contract 88-67 this amount would be halved to $927,140.

B.2 NON-REJECTABLE LOTS

Of the remaining non-rejectable material, the average pay factor was 0.977. Of this non-rejectable material, 256 lots, representing 512,000 tonnes or 65.6%, would have received full payment. Fig. 3 shows the occurrence of penalty points. The picture is similar to the data from the rejectable lots with the one exceptional contract (88-67) omitted, but with some differences. The contribution from the AC content is considerably more in the non-rejectable lots and the major contribution from the fine aggregate fraction is now shared between the 300 and 600 µm sieves.

Fig. 3 MTO FULL CRITERIA NON-REJECTABLE MATERIAL



With an average pay factor of 0.977 the price penalty would be 2.3%. Hence if the scheme had been applied to all hot mix placed on Ministry contracts in 1989 the price penalty of 2.3% would have been applied to 1,463,643 tonnes. Assuming a cost of hot mix of $40 per tonne this represents a total price penalty of $1,346,551.

ANALYSIS BY MTO CRITERIA - REDUCED NUMBER OF SIEVES

The suggestion was made that "....the gradation of the aggregate on one sieve usually is dependent, in part, on the gradation of the aggregate on the next largest sieve. Thus, if the gradation is off on one particular sieve, it is likely also to be off on several adjacent sieves.....It is thus suggested that the number of sieves subject to the assessment points be reduced." It was recommended that only two coarse aggregate sieves be included plus the 4.75 mm. For the fine aggregate fraction, it was recommended that the 1.18 mm and the 150 µm should be omitted and consideration should be given to omitting the 2.36 mm sieve as well, although this sieve was retained for the purposes of this simulation. In carrying out this exercise, no redistribution of adjustment points was made; the adjustment points were accrued in the same way as when the full gradation was considered.

B.3 REJECTABLE LOTS

Following these recommendations the number of rejectable lots identified is reduced to 9 representing 18,000 tonnes or 2.31 % of the total. Contract 88-67 again contributes significantly to the total of rejectable lots but 6 lots would still be identified as rejectable if this one contract were excluded.

Fig. 4 MTO REDUCED CRITERIA
REJECTABLE MATERIAL

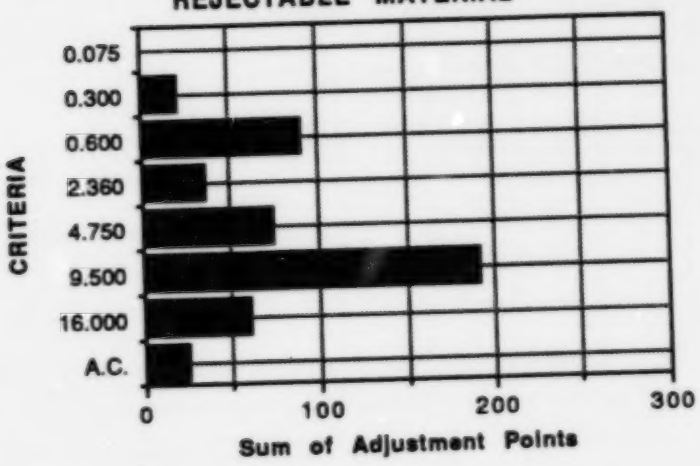


Fig. 4 shows the occurrence of adjustment points for rejectable material with a reduced number of sieves. For the acceptance of the coarse fraction, the 16.0 mm and the 9.5 mm sieves were retained. Note that the data derived from contract 88-67 is included in this Figure.

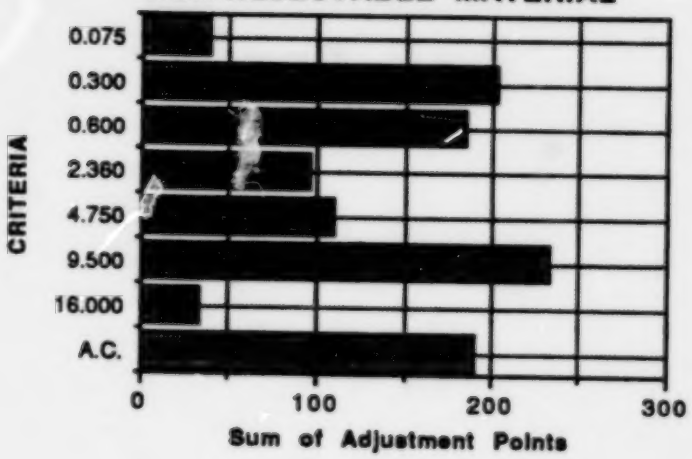
If the acceptance scheme had been applied to all hot mix placed on Ministry contracts in 1989 a projected total of 34,881 tonnes of mix would have been rejectable. At a price of $40 per tonne this represents $1,395,240. If test data from Contract 88-67 is excluded this cost would be reduced to $927,140.

B.4 NON-REJECTABLE LOTS

Fig. 5 shows that the occurrence of adjustment points for the non-rejectable lots follows a very similar pattern with a reduced number of sieves to that with the acceptance based on the full gradation. The adjustment points are again

concentrated on the AC content and the 9.5 mm, 600 µm and 300 µm sieves. The number of lots that would have been paid at the full price increased from 256 to 262 representing 524,000 tonnes or 67.2% of the total. The average pay factor was 0.980.

Fig. 5 MTO REDUCED CRITERIA NON-REJECTABLE MATERIAL



If the acceptance scheme had been applied to all hot mix placed on Ministry contracts in 1989 a projected total of 1,475,119 tonnes of material would have received the average pay factor 0.980 representing a price penalty of $1,180,095 assuming a cost of hot mix of $40 per tonne.

APPENDIX C

Analysis by ASTM Criteria

ANALYSIS BY ASTM CRITERIA - ALL SIEVES

The ASTM criteria are detailed in specification D3515 "Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures". The tolerances for 4 sub-lots are summarized (with MTO criteria for comparison) as follows:

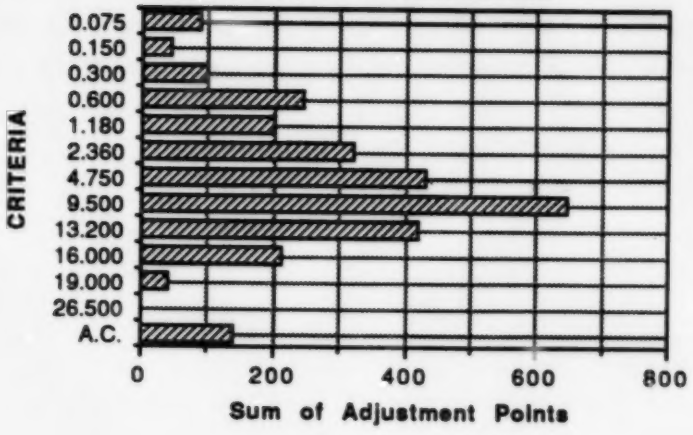
CRITERIA	ONTARIO SPEC.	ASTM D3515
19.0 mm	±5.0	±4.0
16.0 mm	±5.0	±4.0
13.2 mm	±5.0	±4.0
9.5 mm	±5.0	±3.5
4.75 mm	±5.0	±3.5
2.36 mm	±4.5	±3.0
1.18 mm	±4.0	±3.0
600 µm	±3.5	±2.5
300 µm	±3.0	±2.5
150 µm	±2.5	±2.0
75 µm	±2.0	±1.5
Asphalt Cement	±0.3	±0.25

As can be seen, the MTO criteria are more lenient than the ASTM requirements, thus it was expected that the price adjustments would be higher when the ASTM criteria were applied and that the number of rejectable lots would be increased.

C.1 REJECTABLE LOTS

The number of lots identified as rejectable was increased from 12 lots using MTO criteria to 44 lots using ASTM criteria, representing 88,000 tonnes or 11.28% of the total. Contract 88-67 again contributed significantly to the total with 13 rejectable lots. If this contract were excluded the total number of rejectable lots would be 31 representing 62,000 tonnes or 7.95% of the total. The distribution of the occurrence of adjustment points was similar to that for the MTO criteria and this is shown as Fig. 6.

Fig. 6 ASTM FULL CRITERIA REJECTABLE MATERIAL

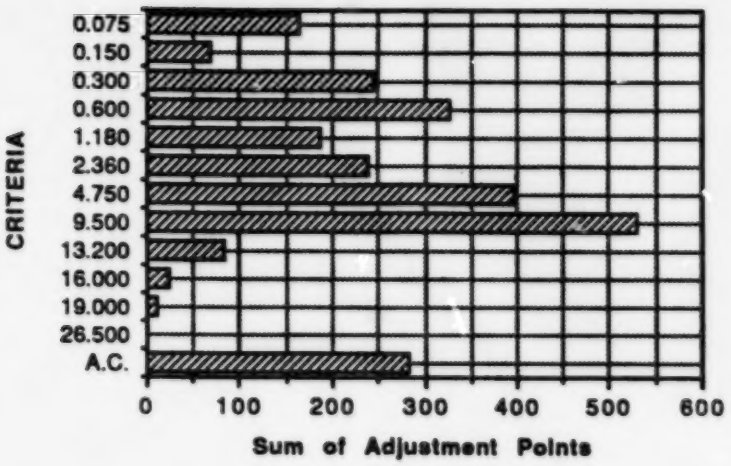


If the acceptance procedure with the ASTM tolerances on all sieves had been applied to all Ministry contracts in 1989 a projected total of 170,328 tonnes of material would have been identified as rejectable. This figure includes the data from Contract 88-67 and represents a cost of $6,813,120 if an average price of hot mix of $40 per tonne is assumed. If Contract 88-67 is excluded from the assessment, the quantity of rejectable material would be reduced to 120,045 tonnes which represents a cost of $4,801,800.

C.2 NON-REJECTABLE LOTS

Of the remaining non-rejectable lots, the average pay factor was 0.930. 134 lots would have been paid at the full contract price representing 268,000 tonnes or 34.4% of the total. The distribution of the occurrence of adjustment points is shown as Fig. 7.

Fig. 7 ASTM FULL CRITERIA
NON-REJECTABLE MATERIAL



If the scheme had been applied on all Ministry contracts in 1989 the 0.930 pay factor would have been applied to 1,339,672 tonnes. Thus the total price penalty would have been $3,751,082 assuming a cost of hot mix of $40 per tonne.

ANALYSIS BY ASTM CRITERIA - REDUCED NUMBER OF SIEVES

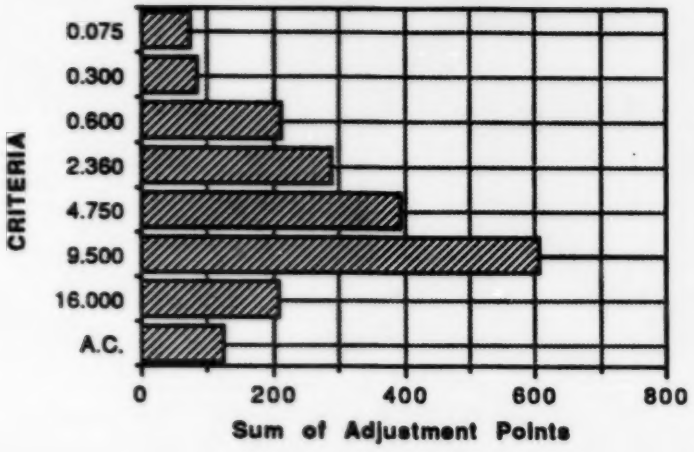
The simulation was run for a final time using the same ASTM criteria but with a reduced number of sieves used to assess the adjustment points. The same sieves were used in this assessment as were used in section 7 ANALYSIS BY MTO CRITERIA - REDUCED NUMBER OF SIEVES.

C.3 REJECTABLE LOTS

The number of lots identified as rejectable was reduced to 36 representing 72,000 tonnes or 9.23% of the total. Of these, 11 lots were from Contract 88-67. Thus with this one contract excluded, the number of rejectable lots was 25 representing

50,000 tonnes or 6.41% of the total. The distribution of the occurrence of adjustment points is shown as Fig. 8.

Fig. 8 ASTM REDUCED CRITERIA REJECTABLE MATERIAL

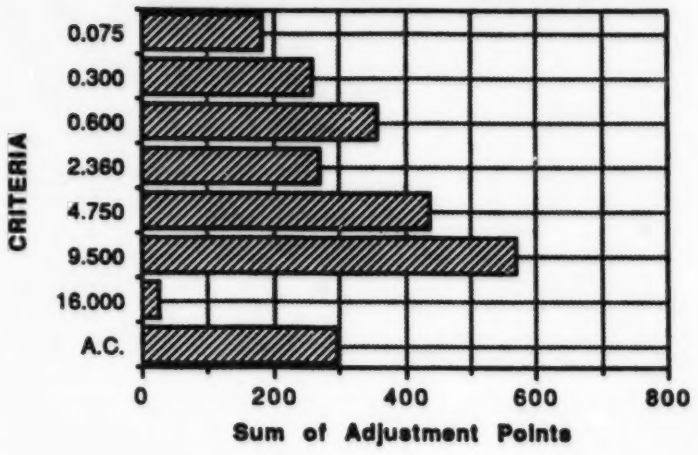


If this scheme had been implemented on all Ministry contracts in 1989 a projected total of 139,373 tonnes of material would have been determined as rejectable if the data from Contract 88-67 is included. This represents a total cost of $5,574,920 if an average cost of hot mix of $40 is assumed. If the data from Contract 88-67 is excluded, 96,791 tonnes of material would have been identified as rejectable representing a cost of $3,871,640.

C.4 NON-REJECTABLE LOTS

Of the remaining non-rejectable lots, the average pay factor remains at 0.930. 135 lots representing 270,000 tonnes or 34.6% would have been paid at the full tender price. The distribution of the occurrence of adjustment points is shown as Fig. 9.

Fig. 9 ASTM REDUCED CRITERIA NON-REJECTABLE MATERIAL



Applying this data to the total quantity of hot mix placed on Ministry contracts in 1989, 1,370,627 tonnes of hot mix would have received the average price penalty of 7.0% which represents a cost of $3,837,756 assuming a cost of hot mix of $40 per tonne.